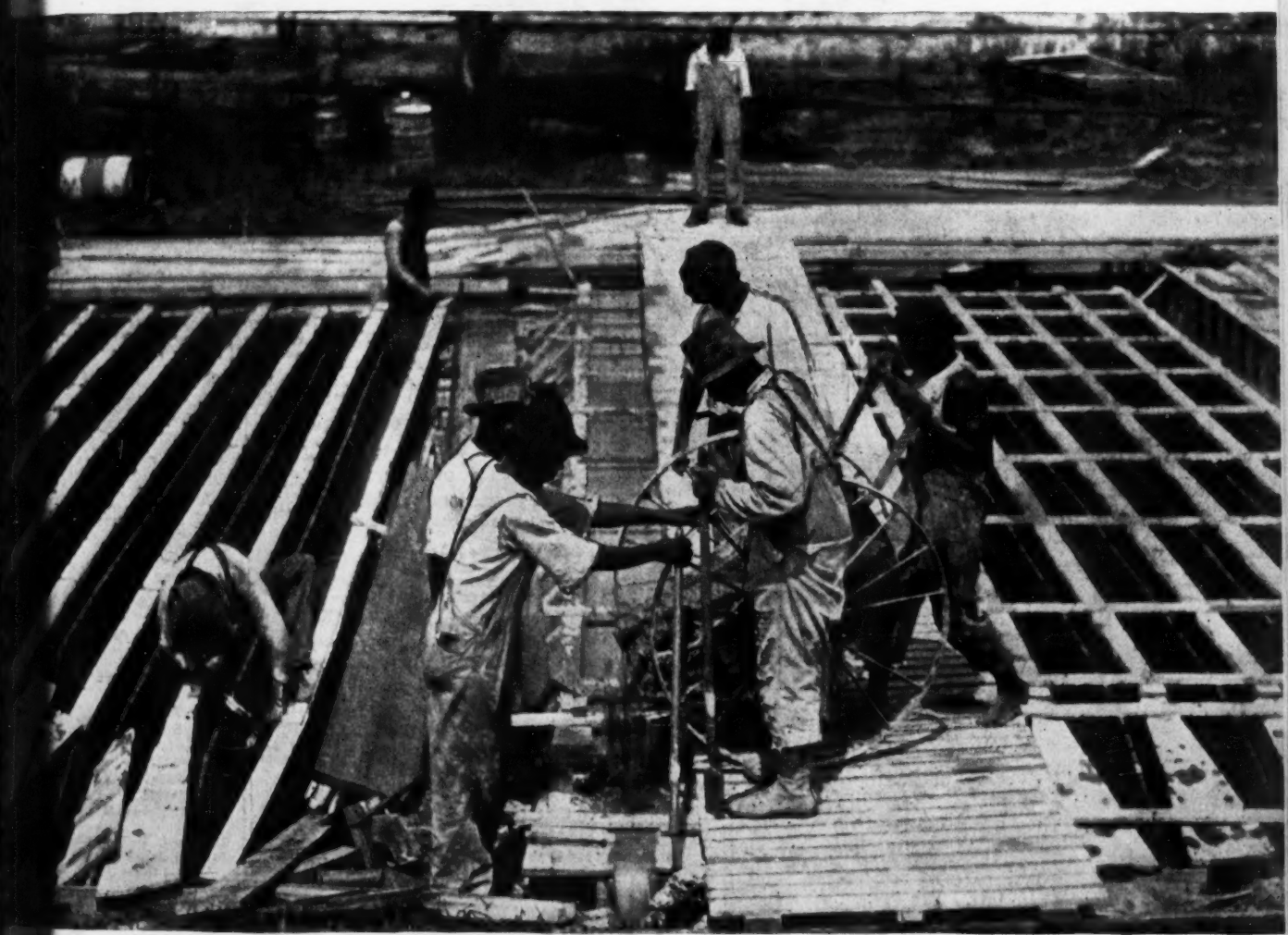
JUL 14 1924

July 10, 1924

Engineering News-Record

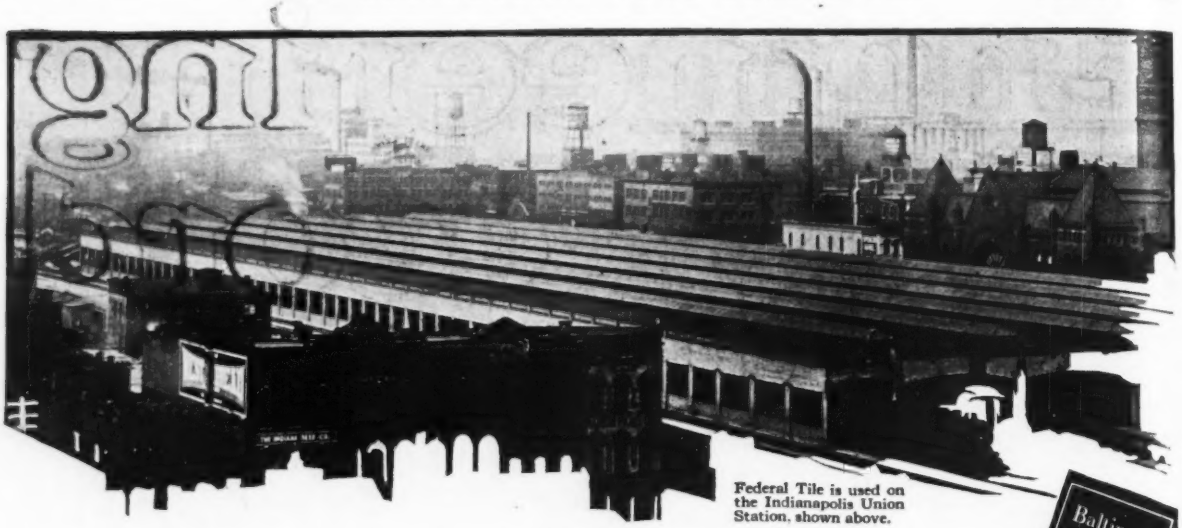
Devoted to Civil Engineering and Contracting.
McGraw-Hill Company, Inc.



Casting Concrete Piles for Santee River Road Crossing, South Carolina

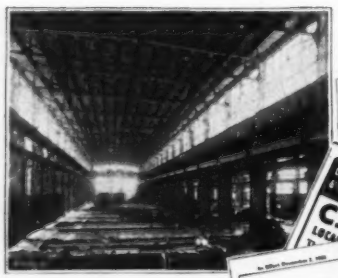
Army Engineers Build Four Sea-Going Electric Dredges
Grand Trunk's Grade Separation Work at Detroit
Abstracts of a Number of Testing Materials Convention Papers
Four-Mile Causeway Carries State Road Over Swamp
Mobile Tower Chuting Plant Used in Building Havana Pier

Also: Ten Short "Job and Office" Articles



Federal Tile is used on the Indianapolis Union Station, shown above.

Railroads can't afford to make the roof an afterthought—



Waco locomotive shops of MK&T — roofed with Federal.

RAILWAY men think in terms of maintenance—for experience has shown them the wisdom of measuring every purchase in cost per year. This training has enabled them to clearly see the unequaled economy of Federal Cement Tile, and as a result there are millions of square feet of Federal Roof Tile on railway stations, shops, terminals and other buildings, large and small, in every part of America.

Under the attack of steam, smoke, ice, snow and molten cinders, these Federal roofs have shown not only the unmatched durability that is possessed by concrete alone, but likewise an unequaled uniformity that could only have been achieved through many years of continual development of one product in the largest plant in the world devoted exclusively to the manufacture of fireproof roofing.

The roof that will stand up on railroad buildings will stand up on any building. The cheapest roof that you can install, the best in appearance, is the no-maintenance roof—and that roof is

These railroads know the saving of roofing for permanence the Federal way—

Illinois Central
Chicago & Northwestern
Chicago, Rock Island & Pacific
Baltimore & Ohio
Chicago, Burlington & Quincy
Chicago & Eastern Illinois
Grand Trunk
Pennsylvania
Chicago & Western Indiana
Louisville & Nashville
Union Pacific
Missouri, Kansas & Texas
Cincinnati, Indianapolis & Western
Chicago & Great Western
Aurora, Elgin & Chicago

Made for all flat and pitched surfaces — natural or red color. Interlocking tile shown opposite. All types described in the book "Covered With Federal."

FEDERAL Cement Tile

made, laid and guaranteed by

FEDERAL CEMENT TILE CO.
608 S. Dearborn St., Chicago

"The Roof for Permanence"

ENR 7-10 S-RTG

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

McGraw-Hill Company Inc.
JAMES H. McGRAW, *President*
E. J. MEHREN, *Vice-President*

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 93 NEW YORK, JULY 10, 1924 Number 2

For a Speedy Recovery

ACCORDING to the latest advices as this issue goes to press Secretary John H. Dunlap, of the American Society of Civil Engineers, is making a gallant and hopeful fight toward recovery from the very serious injuries he received in the railway wreck at Buda, Ill., on his way home from the S.P.E.E. convention. The prayers of the profession, from which the wreck has already taken grievous toll, go out for him.

To Broaden Specialists

IN SAN FRANCISCO last month a floor discussion was started at the A. A. E. meeting as to the relative advantages of the large and the small engineering school. The question was not settled; that would hardly be expected. But the arguments were interesting. The small school men emphasized the smaller classes, with consequent closer contact to subject and professor and the fewer number of young and inexperienced instructors. The university men put their faith in the larger plant and greater capital which would attract better teaching talent and permit greater diversification. But neither, so far as the record goes, referred to what is the commanding virtue of the large school—that is the associations the engineering student gets with interests other than engineering. The study of engineering is confining and specialized and students too frequently carry this narrowness with them into practice. Four years of exposure to the atmosphere of the university with its many kinds of men and many varieties of culture, cannot but have a liberalizing influence on the young engineer which he sorely needs. The smaller and more specialized school may recognize this lack and attempt to supply it by other means. Certainly, the obligation to do so always exists.

Bad Professional Practice

ONE of the many perils of too rapid growth—though to be sure a minor one—is illustrated in the advertisement for engineering services that the city of Los Angeles has had to resort to. As reported in our news columns this week, the city engineer's staff and facilities have become sadly insufficient to cope with their multiplied duties, so a certain amount of work, so far entirely relating to the preparation of new public improvement ordinances, has had to be farmed out. It is bad enough that the city cannot keep its machinery up to its growth, but it is much worse that apparently from fear of charges of favoritism the city engineer has felt called upon to advertise this outside engineering work, and to let it to the lowest bidder. This is bad professional practice, the evils of which are sufficiently self-evident to require no argument or proof. It is difficult to see any justification for it, though there is the explanation of the political subordination of a city engineer's office afraid to select engineers on their merits and at a fair price.

Only Partly Completed

THE middle of July is not exactly the psychological moment to arouse any great enthusiasm in the storage of coal. It is to be feared, therefore, that the long brewing report of American Engineering Council will fall on temporarily deaf ears. Next winter—or the winter after if there is plenty of coal now on hand—the true statement of the coal case made by the engineers may have some effect on the public, but even then it will require some consistent and emphatic publicity work. The mere iteration of facts, unfortunately, does not in itself cause those facts to be acted upon. This is particularly true of the coal situation. It has been fairly obvious for years that the storage of coal in localized units would permit a smoothing of the curve of production and transportation with a resulting improvement in the whole complicated machinery of the coal business. But the difficulty has been in getting the thousands of individuals who control those small storages to fill them up in spring and summer, and the Council report offers no solution of this hitherto insoluble problem.

Functional Adherence

IT IS not enough to have in mind the function of an engineering work or other object of expenditure solely when it is being designed. Function should be constantly kept in mind after the work has been finished and when proposals arise to devote it to some purpose foreign to the original intent. A realization of this, even if not in set terms, was the guiding force in the strong display of public opinion which has recently again saved a considerable portion of Central Park, New York City, from invasion. After months of persistence for and against the project to create an art and music center in the southwestern corner of Central Park, the city authorities and the private promoters of the project, yielding at last to public opinion, have decided to acquire private land for the purpose near the south of the park. A park area of greater or less extent around any art or music center group of buildings might be warranted in any city but to put such structures in what is primarily a park is always a questionable element in original design while it is a kind of thievery to invade for that or any other purpose an area that has long been devoted to park purposes and whose need to that end has been multiplied many times by a vast increase in population. Functional adherence is a sound doctrine that should be observed through a wide range of municipal and other engineering work.

Typhoid Reminders

REMINDERS of the water-borne typhoid epidemics so common in the past are afforded by such happenings as the outbreaks at South Pasadena, Calif., and at Ramsay, Mich., noted in our issues of June 12, p. 1018, and June 26, p. 1105. The Ramsay outbreak

was in a way more excusable than the one at South Pasadena because the Michigan community is a small lumber mill town with a large percentage of non-English-speaking foreigners, while the California city is much larger and older, and has a citizenship far more well to do and with much more civic experience than that of the Michigan towns. Moreover, while at Ramsay the water-supply facilities were crude at South Pasadena they were apparently supposed to be satisfactory in every way, except perhaps as to water shortage. It is true that the most ordinary precautions against water infection were not taken in the Michigan village and that this lack suggests the need of material improvement in local and state health supervision in Michigan. It is also true that the lurking danger at South Pasadena was of the sort likely to remain unknown until revealed by an epidemic—after which it is easy to see the danger from long-continued close juxtaposition of a sewer and a thin sheet metal water pipe standing empty for hours at intervals. It should be somebody's business in all cities, towns and villages of the country to guard against such outbreaks as these and many others that differ in kind rather than degree of danger. Chance contamination of underground supplies, cross-connections between what are generally well guarded public supplies and unguarded private supplies, proximity of leaking water and sewer mains, supposed disconnected or sealed connections with old sources of supply, abandoned because polluted, are all too frequent and should be immediate points of attack on the part of water-works officials and local and state health authorities.

Cross-Connections Doomed

PROHIBITION of direct connections between public and private industrial systems of water supply are now regarded by many if not most water-works men and public health authorities as essential if outbursts of water-borne intestinal diseases are to be prevented. Acting on this belief the State Board of Health of Washington has adopted the drastic regulations printed on another page. The regulations seem to have been prompted by the unfortunate experience at Everett, Wash., last year, also summarized in this issue (p. 59).

Although most of the typhoid outbreaks attributed to cross-connections have occurred where double check valves were not used, and although some water-works engineers and superintendents believe that double check valves afford ample protection against the entrance of polluted water into public water-supply systems through cross-connections, the discussions before water-works and health conventions indicate that cross-connections are doomed. Doubtless they will continue in use for a considerable time in many places, for some cities and states await an epidemic before prohibiting their use while some have not even got as far as to require double check valves and of those that do few require inspection that is adequate in frequency and thoroughness—if indeed that is possible. Then, too, the fire insurance companies have to be reckoned with. Some of them have a representative at every water-works convention ready to spring to his feet whenever a word is said against cross-connections.

There are arguments on each side that deserve consideration, but the weight of the evidence is against permitting cross-connections. The arguments of the property owners and fire insurance companies in favor of cross-connections are chiefly economic, although it is contended that cross-connections afford protection of life against fire. But the human risk caused by fires due to their absences is small compared with the menace to life and health from the badly polluted water so commonly used in private fire protection systems. Consider, for instance, in terms of dollars alone, what the epidemic of typhoid and other intestinal troubles cost Everett, Wash., in sickness and health as compared with any probable saving of life and limb from fire due to the use of the cross-connection that was the means of the outbreak!

True, most of the cross-connection typhoid outbreaks have occurred where there was only a single check valve and little or no inspection of that; but instances of a pair of check valves passing water when they were supposed to be tightly closed have been reported, and cases of single valves partly or even wholly open are often cited. If a structural defect on the one hand or on the other a chip or some other operating accident allows a single valve to pass water when it is supposed to be tightly closed then one of these things may happen to a second valve at the same time, even though the probabilities are heavily reduced. Inspection at best is a weak reliance, unless far more frequent and competent than has ever been deemed practicable, since leakage, once set up, is a continuing danger, and if it happens at all it may come soon after an inspection.

One thing is certain: the *single* check valve is a menace that should not be tolerated by any city or state authority. So far as we are aware, none of the fire insurance companies defend it. The same should be true of any and all owners and managers of industrial plants. The least that should be tolerated is double-check valves, properly recorded, inspected and tested.

Safety to life and health lies in the absence of all direct connections between public and private water supplies. If the public supply has capacity and pressure of value to reinforce or supplement the private supply of an industrial plant then the water from the public supply can be utilized without danger and at no great additional expense by delivering it into a tank provided by the industrial plant under some arrangement that renders impossible the passage of water from the private to the public supply, as the Washington regulations specify.

What a Railroad Means in Power

STRIKING FIGURES of the power required to run our railroads are given by some recent figures on the New York Central. This road comprises 12,000 miles, about 5 per cent of the total mileage of the country. To operate this mileage, the aggregate capacity of the steam and electric locomotives totals 11,000,000 hp. as against a total of 53,000,000 hp. reported by the U. S. Census as the installed horsepower of the other industries of the country. On the basis of the New York Central figures the combined capacity of the steam locomotives of the country is around 200,000,000 hp. or nearly four times the capacity of all the other plants of the country.

This does not mean, of course, that the railroads require this much continuous power to operate them, for most locomotives exert their maximum capacity only

now and then and are wholly idle a large part of the time. But assuming a load factor as low as 5 per cent the railroads require 10,000,000 hp. to operate them, or 1,000,000 hp. more than the total installed horsepower of the hydro-electric plants of the country and one-fourth of the total potential water power.

These startling figures are of particular interest at this time when we hear so much about harnessing our water power to electrify the railroads. Of course the traffic density does not warrant the electrification of many railroads but if we accept the figures in Baum's Atlas, which states that there are 50,000 miles on which electrification is justifiable, as substantially correct, then 5,300,000 hp. will be necessary for railway electrification alone. Before the railroads are ready to absorb this power the installed capacity of the other industries will have passed the point where they could use all the potential hydro-electric power of the country. Obviously then we will not be reducing our draft on our coal reserves by electrifying our railroads but we will be getting twice the amount of power from the coal now burned under the boilers of many locomotives by using it to develop electric energy in a few large central stations. In view of the magnitude of our railroad power requirements this saving will be well worth while.

Permanence in Water Power Tunnels

HOW shall a high "factor of permanence" be obtained in designing the lining for a tunnel built to serve a hydro-electric plant? There is little or no experience with western tunnels of modern size—say 20 ft. in diameter and several miles long—that extends over periods as long as 50 years, yet many such tunnels are now being built in the West and estimates affecting the life of water power developments dependent upon them span a 50-year period unhesitatingly and count on the tunnels as well as dams and certain other structures as being still in good condition at the end of that time.

Trouble in tunnels has been one of the most remote sources of interrupted hydro-electric service; it comes near the bottom of the list of dangers besetting hydro-electric operation. In fact a concrete lined tunnel is looked upon as the most nearly permanent form of supply structure that can be used and is much preferred to flume or pipe lines. Then, too, the futility of any attempt to design against the stresses set up by tectonic movements is fully recognized, first because there is no way to estimate even approximately what such stresses may be and second because such stresses might easily exceed the strength of *any* construction. Nevertheless there are certain dangers that have increased as larger and longer tunnels have come into use and, correspondingly there is need for a consideration of these dangers to see what there may be of increasing safety without excessive cost.

It must be remembered that in "young" mountain ranges—and the mountains of western United States are still quite young geologically—more or less settlement and movement is still taking place. In general the danger from movement or slip on a fault, excepting a few well-known lines of faulting, is believed to be small compared with the shock of an earthquake originating on a fault, perhaps many miles away. Nevertheless, in weak ground, particularly, there may be danger from vibrations which would cause local disturbances, for example, where joints converge upward leaving large wedges hanging insecurely.

Long hydro-electric tunnels traversing many different earth strata are frequently lined with concrete—are always so lined, in fact, where the formation is found to be at all loose. As decades roll by and the tendency to slight shifting or settlement develops, considerable pressures will be exerted on such linings. If cracking occurs the resultant leakage will cause extensive saturation—a condition that might well increase the tendency to slip along planes where the resistance is least.

Miners are used extensively in driving power tunnels and their ideas and advice carry weight in tunneling problems. The miner's experience however has been in a different field—a field where only comparatively short-lived structures are required. The ordinary mining operation usually finishes up and abandons a mine in a comparatively short period of years. Then, too, mine tunnels are short and are seldom lined with concrete, so that slow and slight movements of earth strata would not likely be serious there. Even so, in some mines where operation over a considerable period of years is planned, very heavy concrete lining is sometimes used. Instances are on record where heavy masonry of this sort has been crushed by slow movement of earth strata.

These considerations give rise to question as to whether the modern long tunnels extending across frequent changes in formation and lined with only a 12- to 18-in. thickness of unreinforced concrete may be expected to remain intact indefinitely and how the lining should be designed, under given conditions, to afford the maximum life within economical limits of cost.

Linings of the thickness ordinarily used are sufficient to seal the tunnel so as to prevent leakage or air slaking of the rock at the same time that the friction coefficient is reduced. Theoretically the ideal tunnel lining would vary in thickness with each change in the condition of rock traversed, but the rock condition is affected by many variables such as strength, texture, induration, decomposition, shearing, saturation, etc., and even with certain knowledge of such conditions it would be impracticable to make frequent changes in lining thickness. However, a careful, expert analysis might show the chief danger of movement to center in a short length of tunnel in which case a thicker lining at this point would afford as much protection as full length lining of the same thickness, and at a great saving in cost.

It would be an excellent practice for power companies to employ that rare but valuable individual, a practical-minded engineer-geologist, in connection with all important tunnel work. His advice about fault planes and shear zones should be considered before deciding upon the exact location of the tunnel and during progress of the work he could make a record of the rock changes before the lining cuts off all further opportunity for examination. Such records would be very valuable in the event of any later earth movement along the tunnel.

In short, uninterrupted service and long life, which are primary necessities in water power tunnels, have heretofore, in large measure, been taken for granted. It would seem to be good economy to use every available means to secure a location and a design in which every reasonable provision is made for a high "factor of permanence."

Four-Mile Causeway Carries State Road Over Swamp

Railway Methods and Equipment Are Used to Build South Carolina Highway Across the Santee River Bottoms—Flood Conditions Add Year to Construction Time

By James Pinnell
Superintendent, Rollins Construction Corp.
New York

and

J. L. Parker
Bridge Engineer, State Highway Department,
Columbia, S. C.

A COSTLY link of the Atlantic Coastal Highway has recently been completed across the swamp bottoms of the Santee River in South Carolina. At a contract price of $850,000 a causeway, alternately of embankment and concrete trestle, takes the road 4½ miles over the river and its bordering overflow land. The structure is deserving of notice in these respects: (1) The conditions were typical of those which prevail at the majority of the streams crossing the coastal plains of the Carolinas and others of the South Atlantic States; (2) there was an outstanding design problem of determining the least ratio of open structure to less expensive embankment which would safely pass the flood waters; and (3) there was a construction task more resembling heavy railway grading and bridging than a highway construction operation.

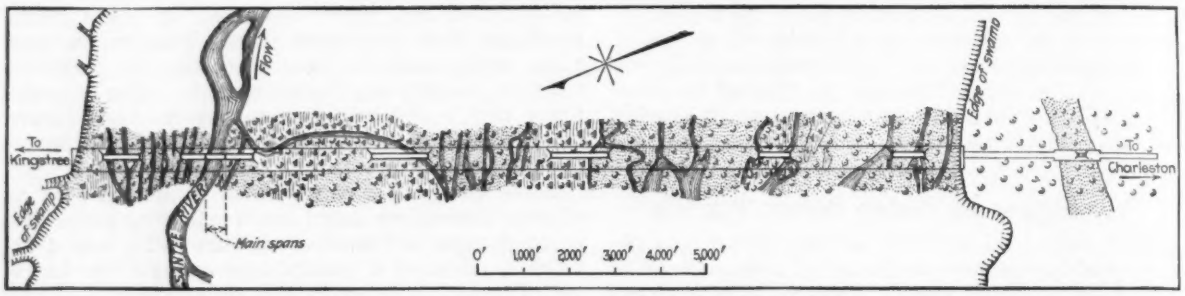


FIG. 1—TOPOGRAPHIC ROUTE MAP OF SANTEE RIVER HIGHWAY CROSSING

Design of Crossing—The determination of waterway in the crossing structure was the big design problem. The factors were width of stream, conditions of flow and relative costs of fill and trestle. Design of structure itself was rather simple.

The selected point of crossing was at Murrays Ferry about 65 miles above the mouth of the river. Fig. 1 shows the topography. The river channel is only 350 ft. wide in a swamp bottom nearly four miles wide with definite edges. At low water the river channel is defined and the bottom has a network of defined creeks and lagoons closely wooded between with trees and undergrowth. At high water the bottom, which is nearly level and only a few feet above low water, is overflowed. During the construction of the crossing the water at times was 10 ft. deep across the valley, in the extreme flood of 1916 a depth of 21 ft. was recorded. There are flood conditions about eight months out of the year. Briefly then, in determining the waterway, the full breadth of the valley had to be considered stream width.

A second complex factor was the flow conditions. The main channel is very narrow but it has a decided effect on the movement of the flood waters for a considerable part of the valley, due to its greater depth and swifter current and also to the fact that the channel wanders from side to side of the swamp. For example, at the bridge the river is on the north side but a few miles above and again a few miles below it is on the south side. Some of the larger creeks affect the flow, and also in certain well defined sections of the swamp the undergrowth is less dense and the current is faster. Under these conditions determination of floodway area and location, in crossing structures, depends upon study of main current threads and speeds and of total volumes.

Comparison of fill and trestle costs, as the third factor, gave the ratio of about one to eight. It was decided to bridge the main channel with three steel spans of 120 ft., 180 ft. and 120 ft., and to provide eight trestles in lengths of 806 ft., 600 ft., 600 ft., 1,393 ft., 1,272 ft., 733 ft., 782 ft., and 183 ft., or a total of 6,369 ft. of trestle. Located on the main flow lines as indicated by Fig. 1 it was believed that the trestles would be ample to pass the water without material ponding or scour. With 17,000 ft. of embankment the ratio of floodway to closed channel was substantially one to two and a half.

Design of Structure—At the crossing the swamp floor is clay and silt to a depth of 8 to 16 ft. and then there are 18 to 40 ft. of coarse sand overlying marl or limestone. The bridge is a simple, steel-truss structure with an 18-ft. roadway, and is carried on concrete piers built in cofferdams or open caissons to marl or rock. The trestle structure was described in *Engineering News-Record* Nov. 3, 1921, p. 725. The plans provided for two types of structure, one having 36½-ft. concrete-beam spans with pedestal-type bents on timber piles, the other having 24½-ft. concrete-beam spans on concrete pile bents. The pedestal type was used where sufficient penetration could not be secured for concrete piles. Altogether there were 262 of the 24½-ft. spans, and 15 of the 36½-ft. spans. The deck of each span has four reinforced-concrete beams supporting a 6-in. reinforced-concrete slab, all being poured in place. Each pier bent has four precast concrete piles, the two outside piles having a batter of 1½ in 12, and the inner piles being vertical. The piles are 16 in. square for piles 40 ft. long or less and 18 in. square for piles more than 40 ft. long. A concrete cap, 30 in. wide, encases the tops of the piles and supports the decks. In all there was 8,700 cu.yd. of concrete.

The embankments have an average height of 23 ft. in the swamp and 10 ft. on the extension, a minimum width of 26 ft. at the top, and a total length of 17,000 ft.

The end slopes run through the abutment piers of the trestles and are riprapped with one-man stone having an average thickness of about one foot. Wooden railings, 22 ft. apart, are used on the embankments. The embankment quantities were 750,000 cu.yd. of fill and some 8,500 cu.yd. of surfacing and riprap. There were 105 acres of heavy clearing.

Construction Plan—In every aspect the construction operation was a "railway job" and called for railway methods and equipment. The first operation, to provide transportation for materials to the site, was to build five miles of standard-gage railway from the Atlantic Coast Line R.R. at St. Stephen to the south end of the work where the contractor's camps and storage yard were located. Then followed the construction of a temporary timber trestle, about 25 ft. high, carrying a standard-gage track, for practically the entire length of the project. This trestle was built on the center line of the bridge, except for detours around the sites for the concrete trestles, and enabled the contractor to place material for the embankments without delays from flood waters. As the swamp was heavily timbered and the right-of-way to be cleared was 200 ft. wide, sufficient timber was available for the trestle without any expense except that of the necessary shaping and placing. This timber trestle was also used in transporting materials for the permanent trestles. Later the ties, caps and stringers of the timber trestle were removed, but the piles were not pulled.

Embankment Construction—Material for the embankments south of the river was taken from a 40-acre borrow pit near the south edge of the swamp, and material for the north embankments was taken from an 8-acre borrow pit near the north edge of the swamp. The embankment work was begun on the south side in

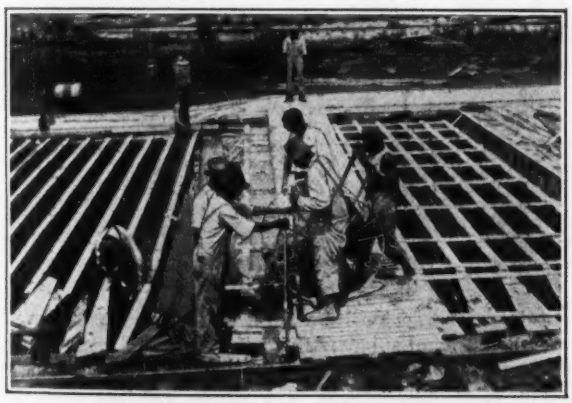


FIG. 2—CASTING CONCRETE PILES FOR TRESTLES

November, 1921. The principal equipment consisted of one No. 70 steam shovel, a 70-ton locomotive for movement of trains in the borrow pit and three trains of 12- and 18-cu.yd. air-dump cars hauled by two 32-ton dinkeys from borrow pit to swamp. The work was so conducted as to provide for a continuous movement of trains, with one train in the borrow pit at all times. As much as 49,000 cu.yd. of material was placed by this outfit in one month and an average of about 30,000 cu.yd. per month was maintained throughout the job.

The material taken from this pit consisted largely of a natural sand-clay mixture, about 75 per cent sharp sand and 25 per cent clay, which was suitable for surfacing material and it was used for surfacing the roadway on embankments throughout the project. The material was dumped from the cars without any attempt to place it in layers. In the engineer's estimate, an allowance of 20 per cent was made for settlement and

FIG. 3—TRESTLE PILES DRIVEN READY FOR CAPPING

subsidence of embankments, but actually this has amounted to less than 10 per cent. The slopes of embankments were designed 1½ to 1 and it is probable that this will be reached in time but at present the slope is nearer 1¼:1.

On two occasions during the progress of the work the water rose to an average depth of about 10 ft. across the swamp and this high water caused some sloughing off of the sides of embankments, but no appreciable amount of material was lost. Considerable sandbagging was necessary to protect the ends of embankments before riprap was placed. As terra cotta drains have been provided for the runoff from the roadway, and Bermuda grass has been planted on the slopes, it is believed that there will be no considerable erosion of the embankments in the future. A total of 646,000 cu.yd. of material was placed in the embankments located south of the river.

Material for the north embankments was placed by means of a 1¼-cu.yd. steam shovel, two small dinkeys and two trains of three-yard, narrow-gage dump cars. The material taken from this pit consisted of clay, having about 40 per cent sand. Altogether about 65,000 cu.yd. were taken from this pit.

Pile Casting and Driving—For making the precast concrete piles for the permanent trestles, a casting yard containing 70 forms, Fig. 2, was established near the contractor's camp and storage yard. Piles remained in the forms after concreting, and were then removed to a storage yard to remain for a curing period of thirty days before driving. The reinforcement for piles was made up and placed in the forms as a unit. A traveling

derrick was used for lifting the piles from the forms and also for loading them on flat cars for transportation to the piledriver. The contractor was responsible for determining the lengths of piles, and from data secured from borings and by driving the wood piles for the temporary trestle the lengths were determined in advance with a high degree of accuracy.

For driving the concrete piles, a steel frame piledriver, on a turntable, having swinging leads and a No. 1 Vulcan steam hammer, was used. In addition to driving the piles, this driver also unloaded the piles from the flat cars alongside of the temporary trestle, Fig. 3, and placed the necessary cribbing and track through the swamp on which the driver was operated over the floor of the swamp. The piles were hauled from the casting yard to the swamp on standard flat cars, four piles to a car, and as there was no storage space in the swamp they were driven directly after unloading. The piledriver of course worked backward under this arrangement. The track was of such height that the driver was above water for the greater part of the time, but it was often partly submerged for considerable lengths of time. Probably 80 per cent of the piles were driven under flood-water conditions. When the pile driving had progressed to the north side of the river, as the water had an average depth of about 4 ft. across the swamp and was above the usual level of track on which the driver traveled, a low timber trestle was built from the river to the north end of the north trestle to permit the driving of piles for the two trestles north of the river regardless of the high water. This low trestle was increased in width at the north trestle in order to support the forms for the concrete decks.

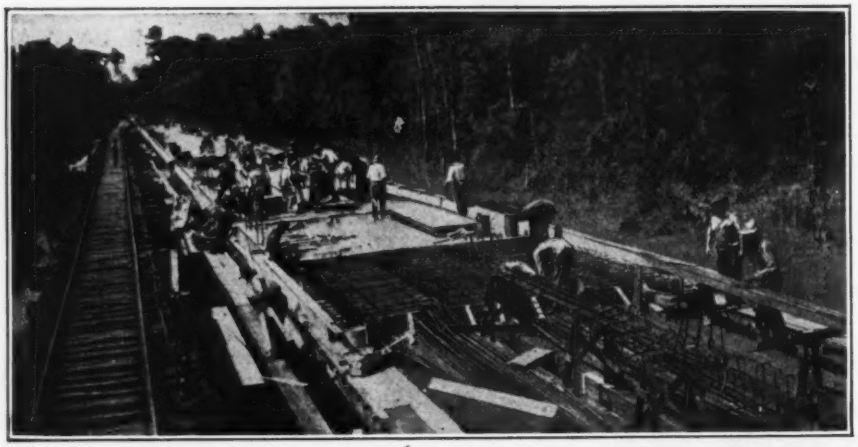


FIG. 4—CONCRETING DECK OF TRESTLE

The penetration of the concrete piles varied from 15 ft. to 24 ft. and the average penetration was about 20 ft. Generally the driving was hard but no difficulty was experienced in securing the necessary penetration and capacity. No attempt was made to stop the driving as soon as the necessary number of blows per inch was obtained, but the contractor was permitted to drive the piles to grade when he preferred this to cutting off the pile. A loss of less than 1 per cent resulted from the cutoffs. As the concrete caps were of such width as to permit of a small variation in the position of piles, and the driving was very accurately done, it was necessary to spring slightly only a comparatively few piles to bring their heads within the caps. Altogether, 908 piles having a total length of 36,630 ft. were driven. The concrete caps were poured in place, the forms being placed at the same time as the forms for the concrete decks.

Deck Construction—Material for the decks, Fig. 4, was hauled from the storage yards by two 32-ton dinkeys in 6-yd. dump cars. A mixing plant was erected at one end of each trestle 800 ft. long or less and at the center of each trestle over 800 ft. long. The concrete was deposited in the forms from buggies. Forty-two sets of forms were provided. Special efforts were made to secure the proper spacing of, and the greatest protection possible for, the reinforcement. Considerable delay was experienced in placing the decks because of the continued high water, the frequent rains, a shortage of labor, and the necessity of so conducting the movement of trains carrying concrete materials as not to interfere seriously with movement of the dirt trains. One set of deck forms consisted of the necessary forms and falsework for placing one span. The forms were collapsible and the various parts could be easily taken down, loaded on flat cars and reassembled in a new location when one section was finished.

Delays and Progress—In general, it may be said that the flood-water conditions did not interfere seriously with clearing the right-of-way and placing embankments, but they did result in serious delay to erecting the temporary trestle, driving the concrete piles and placing the decks for the concrete trestles. As the working conditions were favorable for only about four months in each year, the contractor's principal problem was to overcome the swamp and flood conditions existing during the remainder of the year. This he did, except on two or three occasions where the water rose to such heights that it was deemed advisable to suspend operations altogether.

FIG. 5—COMPLETED ALTERNATE EMBANKMENT AND TRESTLE

The total cost of the project amounted to approximately $850,000, half of which is paid by the federal government and the other half by the Santee River Bridge District, composed of Charleston, Williamsburg and Berkeley Counties. Construction was begun on the substructure of the main spans in June, 1921, and on the approaches in September, 1921. The substructure for the main spans was built by Simons-Mayrant Co. of

Charleston, S. C., and the superstructure by the Atlantic Bridge Co., Roanoke, Va. The contract for the approaches, which constituted nearly 85 per cent of the project, was awarded to the Rollin Construction Corp., New York City, and was executed under the direction of James Pinnell, superintendent. Subcontracts were awarded to A. T. LaBruce & Co., Charleston, S. C., for clearing the right-of-way and erecting the temporary trestle, and to the Cornell-Young Co., Macon, Ga., for placing the south embankments, the remainder of the work being done by the general contractor.

All work was done under the direction of the State Highway Department, Charles H. Moorefield, state highway engineer; J. L. Parker, special bridge engineer, and W. C. Roberts, resident engineer.

Suspension Bridge Pier Foundation Built by Unusual Method

Florianapolis Bridge Pier Founded on Rock by Concreting Separate Pits Sunk from Floor of Cofferdam

IN THE construction of the Florianapolis suspension bridge, in Brazil, whose substructure has just been completed, an original method was used on one of the main piers to reach rock at a depth greater than a cofferdam could handle.

The bridge, which will have a main span of 1,114 ft., and so will be not only the largest bridge in South

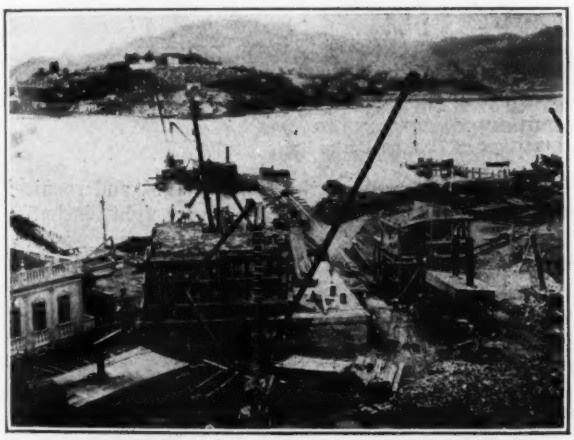


FIG. 1—CONSTRUCTION OF CONTINENT ANCHORAGE
Island of Florianapolis in background, and construction plant for continent main piers off shore.

America but also the longest eyebar suspension bridge in the world, is being built by the state of Santa Catharina, Brazil, to connect the island capital Florianapolis with the main land (see *Engineering News-Record*, Oct. 11, 1923, p. 592). Work was begun in the spring of 1923. Huge irregular boulders in the ocean bed were found to make the rock soundings quite misleading, and the presence of these boulders and the slope of the bedrock surface complicated the foundation work.

Open cofferdams of steel sheetpiles were driven for the four main pier foundations. The sheetpiles went down to 38 ft. below mean water level, while rock lay at depths from 30 to 60 ft. below water.

In the case of the north continent pier, after excavation within the cofferdam was carried down to near the bottom of the sheetpiles, a test pit was sunk within the cofferdam to bedrock at El. —59. This test pit was concreted, and then adjoining sections were excavated and concreted, in succession, until the entire area within the cofferdam had thus been underpinned down to bed rock. On the concrete footing so obtained the square

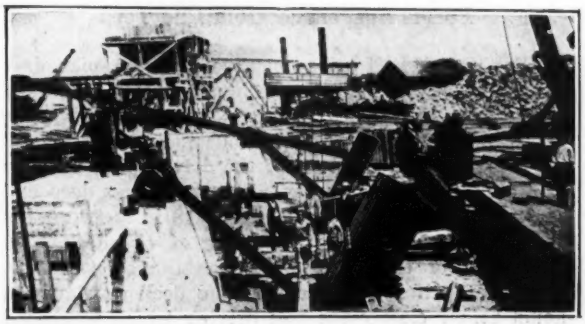


FIG. 2—PLACING STEEL IN CONTINENT ANCHORAGE.
Temporary guide pedestals for accurate setting of main pins at anchor chains. Webs of pedestals were burned away after concreting of grillages.

pier was built up, stepping off at different levels and terminating in a cylindrical shaft and coping.

Nearby, in the south continent pier cofferdam, rock occurred at El. —32 over the greater part of the area, falling off sharply to El. —60 at one corner. Only this corner had to be sheeted down below the cofferdam sheeting. The two island main piers reached rock at El. —50.

Decidedly different conditions prevailed at the two anchorage sites. On the continent the anchorage had to be built on a pile foundation, rock being quite deep. On the island side the anchor girders and eyebars were placed in pits excavated in the solid rock, and the anchorage built up above these pits in form and dimensions similar to those of the continent anchorage.

Fabrication of the superstructure steelwork by the American Bridge Co. is approaching completion. It is expected that erection will be completed early in 1925.

Byington & Sundstrom, of São Paulo, Brazil, are contractors for the bridge. Robinson & Steinman, New York, consulting engineers to the contractors, designed the bridge; and L. N. Gross is associated with them as consulting engineer on construction. G. A. Brinkerhoff represented the consulting engineers as resident superintendent on the foundation work.

Power Possibilities of the Arkansas River

Nineteen small power projects are possible on the Arkansas River in Colorado, according to a report of the Geological Survey, totaling 44,000 hp. for 50 per cent of the time and 24,000 hp. for 90 per cent of the time. The sites are all above Canyon City, Colo.; below that point the entire flow of the river is used for irrigation purposes. The cost of developing these sites will be relatively high because of the small flow and low head and restrictions on regulation due to irrigation requirements. Six reservoir sites were found, but owing to the high cost of construction only two are considered feasible, one with a capacity of 10,000 acre-ft. and the other of 130,000 acre-ft. Manuscript copy of the report is available for examination at the office of the Geological Survey, in the Interior Department Building at Washington, or at the district office of the Survey at Denver, or may be sent to district offices for consultation on application to the survey director.

Mobile Tower Chuting Plant Builds Concrete Pier at Havana

Stiff-Leg Tower, Having a Counterweight Chute, Travels on Apron Around Pier House—Deck Forms Suspended from Pile Tops

CONSTRUCTION of a massive concrete pier deck and house on concrete piles in deep water in Havana harbor last year displayed ingenuity in devising the concreting plant and in form construction. All work had to be done on the tops of the driven piles or from the water alongside the pier. The water was deep and also there was a scant clearance of 18 in. between the mean tide level and the underside of the deck. On three sides of the work there was the open harbor. Prompt execution required that the deck construction should follow closely the pile driving which proceeded from the shore outward. Under these general conditions there were the alternatives of a floating plant or plant carried on the pile tops. The latter plan was adopted except that concrete materials were carried by barge from the shore to where the concreting plant was working.

FIG. 1—VIEW FROM HARBOR END OF CONCRETE PIER
One of three identical piers built for the Port of Havana Docks Co.

Structurally the pier was nearly a duplicate of two others built some ten years ago, described in *Engineering News*, June 25, 1914, p. 1397. Fig. 1 is a view from the harbor. The pier deck was 214 ft. wide and 626 ft. and 582 ft. long on the sides. On this deck was a pier house 154 ft. wide and 40 ft. shorter than the deck. The pier house was two stories and at the shore end butted into a head house three and four stories high with a tower. Only the pier deck and house are described here. The deck was designed for a load of 250 lb. and the second floor for a load of 400 lb. per square foot. Structurally the deck consisted of thick reinforced caps over groups of piles under the columns and of a one-way-reinforced 8- to 18-in. floor slab between caps. The columns were concrete reinforced with structural steel and the second floor was ordinary slab and girder construction. In the deck and house there were about 12,000 cu.yd. of concrete, all heavily reinforced.

The great bulk of the concrete to be placed was in the deck and the first story including the second floor of the pier house. Adopting this as the range of direct placement it was found that chuting from a 100-ft. tower would easily cover the work, with the tower standing on one of the side deck aprons which was the logical location since it was outside the pier house structure and alongside the pier edge to which scows could be brought. Also the deck apron, being designed to carry railway tracks, had ample strength to carry the tower. And finally the apron afforded a clear runway for mobile equipment. The decision followed: (1) To build the south side-apron continuously about 100 ft. ahead of the main structure as a trackway; (2) to mount a 100-ft. tower, with chuting outfit, on a carriage with bins and mixer; (3) to follow the tower outfit on the same track with a locomotive crane lifting concrete materials to the bins from scows moored alongside. The arrangement is indicated by Figs. 2 and 3.

In the design of the concreting outfit two or three details called for care. Tower, sliding frame, counterweight boom, and chutes were standard products. The tower, however, could not be guyed and had, therefore, to be stayed by stiff-legs. This arrangement made it desirable to keep down the tower height and required a very sturdy carriage to take the weight, including mixer and filled bins, of 200 tons and to resist the twisting stresses from the stiff-legs. As built, the carriage was a heavy timber frame on 20 double-flange wheels which traveled on four lines of 60-lb. rails spiked to cross-ties. Anchor plates on the carriage held the feet of the stiff-legs, two going to nearly the top of the tower and two to about mid-height. These legs were 87 ft. and 52 ft. long and were of steel.

The mixing unit was ordinary. It consisted of a 1-cu.yd. mixer, an overhead three-compartment bin and the usual accessories. All machinery was motor-operated from a power line carried out from shore and having outlets every 50 ft. for cable connection from the plant switchboard. Similarly a water supply line was carried out from shore and tapped at intervals for hose connection. A 50-hp. motor handled the tower bucket and sliding frame and a 25-hp. motor operated the mixer.

In operation the traveling tower plant ran on a section of track about 100 ft. long which was taken up from behind and relaid ahead as the work advanced. The outfit was found to be very mobile, it was moved forward and back to place even a few yards of concrete. With bins filled, the stability was ample when working with the full chuting radius. As an additional safeguard, however, the carriage was anchored down to the deck when working and the plant was shifted

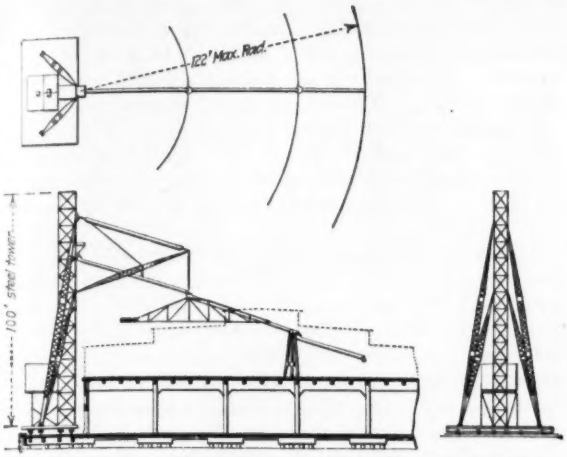


FIG. 2—STIFF-LEG TOWER MOBILE CHUTING PLANT FOR HAVANA PIER

Plan and elevation showing traveling carriage carrying a complete 1-yd. mixing and hoisting plant, storage bin for material, 100-ft. steel tower and 50-ft. counterweight boom and sliding frame attachment.

only when it was calm. Behind the tower plant came the locomotive crane which supplied the bins by clamshell from a barge alongside. The barges were loaded at the bulkhead line from motor trucks.

Special consideration had to be given to the deck forms. The heavy deck slab was supported on the pile caps spaced 20 ft. on centers longitudinally with the pier and 30 ft. on centers transversely with the pier. This work was all done over deep water so the pile tops were the only points of support for this formwork. It was essential that these forms be taken down without sending laborers underneath the pier, as there was a clearance of only 18 in. between the bottom of the concrete deck and the water at mean tide, and much of the formwork projected down into the water. It was necessary, therefore, to design a form which would be entirely supported from above and which, when the concrete had sufficiently set to permit removal, could be dropped by workmen from above the pier.

The initial support for the formwork was in the nature of four 6x12-in. timber posts resting on the corners of the concrete pile tops as shown by Fig. 4. Across the heads of each set of two posts and resting on shoulders cut into them, were beams constructed of two 9-in. channels. These structural steel caps projected out beyond the 6x12-in. supports so as to give a bearing for the main timber trusses at a point in line with the edge of the pile tops. The ends of these structural steel caps carried bearing plates on which rested the ends of the timber trusses. The timber trusses for the typical bays were constructed of two pieces of 2x12-in. yellow pine as top chord supported by two 1-in. truss rods, giving a total depth of truss of 3 in. The top chord of these trusses was supported by two 8x8-in. timber struts situated at the third points. The formwork proper was supported on a 4x8-in. ledger hung underneath these trusses by ⅝-in. round hanger bolts spaced about 26 in. on centers. These ledgers supported the ends of the transverse built-up frames, which, in turn, carried the panels on which the concrete was poured. One intermediate timber beam without truss rods, composed of two pieces of 4x12-in. timber, was supported at the same level as the trusses. The structural steel caps had a bearing plate at their center points to carry the ends of this intermediate beam. This beam supported, by means of hanger rods, the 2x8-in. spreaders situated 2 ft. 6 in. on centers which carried the panels on which the concrete between the pile caps themselves was poured.

In order that the forms might be lowered without sending a man underneath the deck, all of the hanger bolts were arranged with the threaded end down. These hanger bolts screwed into nuts which had been welded to the 4x4-in. washers which, in turn, had been fastened by two nails to the 4x8-in. ledger. In this way no hanger bolts would be dropped into the water when the forms were struck and the washers as well as the nuts remained fastened to the ledgers.

The forms under the main deck were left undisturbed for seven days, as, of course, it was impossible to do any reshoring. When the time had arrived for the forms to be lowered, the anchor bolts would be taken out from above and as soon as the last bolt was released, the ledger would drop into the water, permitting the transverse girders and also the panels resting upon them to drop into the water, from which all parts of the forms were retrieved by men working on floats at low tide. Even at low tide there was a clearance of only 2 to 3 ft. between the surface of the water and the bottom of the concrete, so it was impossible for the men to get under the deck until the forms had been dropped into the water.

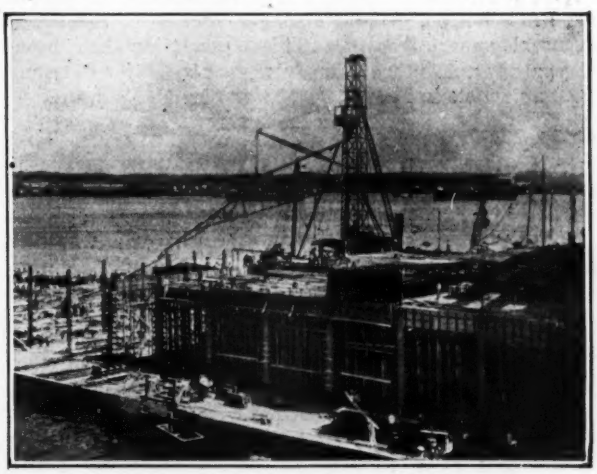


FIG. 3—VIEW OF PIER CONSTRUCTION AND CHUTING PLANT

In order that there might be no question about the forms dropping when the hanger bolts were released, no staples were permitted to be driven into the panels for holding the reinforcing steel in place. In the beginning of the work, a number of 6x6-in. holes were blocked out of the floor slab so that if perchance the forms did not drop of their own weight when released, they could be pried down from above through these holes. After no trouble was found, the pry holes were discontinued.

The trusses, timber beams, built-up frames and other parts of the deck forms became very bulky if designed with the factor of safety generally used in designing permanent structures. The arrangement of the trusses and hangers permitted constant inspection to note deformation. A failure of a section of the deck forms would have produced serious consequences. It was, therefore, decided to inspect carefully all materials before using and design these forms with a factor

of safety of 2. The various parts of the deck forms were built on this basis and then carefully tested out before using and it is interesting to note that there were no failures of either timber work or truss rods.

Tubes of corrugated paper were used around the hanger bolts where they passed through the concrete

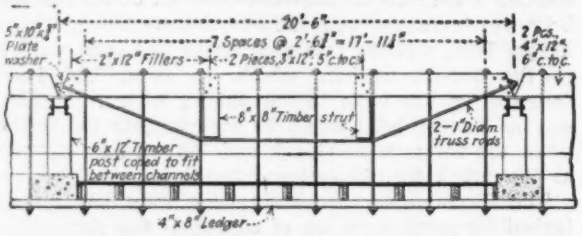

5"x10"x¼" Plate washer
20'-6"
7 Spaces @ 2'-6½" = 17'-11½"
2 Pcs. 4"x12" 6' c.to c.
2"x12" Fillers
2 Pieces, 3"x12", 5' c.to c.
8"x 8" Timber strut
2—1" Diam. truss rods
6"x 12" Timber post capped to fit between channels
4"x 8" Ledger

FIG. 4—DETAIL OF DECK-SLAB FORM

slab, and with this precaution no trouble was encountered in releasing the bolts, even when they passed through 18 in. of concrete. The forms were used about eleven times during the work.

All of this work was under the general supervision of Charles E. Lund, local manager for the Parklap Construction Corporation for which George Perrine was resident engineer. R. A. McMenimen acted as resident engineer for the Raymond Concrete Pile Co. on the foundation work done by it; and the superstructures by the Turner Construction Co. came under the control of R. C. Wilson, general manager, and F. E. Schilling, general superintendent. This description has been prepared from information furnished by Major Perrine, and an article in *Turner Constructor* by Mr. Wilson.

Ohio Tornado Destroys Lorain Business District

Theater Wrecked by Falling Debris—About 1,000 Dwellings and Stores Destroyed and 65 Lives Lost

ON SATURDAY, June 28, during an intense rain and wind storm covering the northern part of the Central States, a tornado passed eastward through northern Ohio, along the south shore of Lake Erie, from Sandusky to near the city of Erie, Pa., doing great destruction at a number of points along its path. Lorain, Ohio, about 25 miles east of Sandusky, suffered most severely. The storm passed through the center of the business section and part of the residential portion, and largely destroyed them. About 1,000 buildings were wrecked and 65 persons killed. A brief account of the effect of the tornado by J. B. Thomas, of Elyria, indicates that only few of the structures involved were of engineering importance.

Lorain, an important Lake Erie port of 45,000 population, is mainly grouped about one long business street, Broadway, running at right angles to the lake shore. South of the city is a large rolling mill of the National Tube Co., and near the lake shore is the Lorain shipyard of the American Shipbuilding Co. The city occupies the intermediate area and extends to the lake, where a new residence district has been developing. The tornado followed Broadway northward, sweeping the center of the city.

Apparently the tornado swung south from the lake into the eastern part of Sandusky, where it blew down the water-works standpipe (the pipe was empty at the time, for cleaning) and destroyed a number of old buildings; it passed south and east in a narrow path, entered Lorain at 5:30 p.m. along the New York, Chicago & St. Louis Ry. (Nickel Plate) and turned north through the city to the lake. Some four miles east of the city it again turned inland to Avon, doing considerable damage there. Minor evidences of tornado action are reported from various points east of here to beyond the easterly border of Ohio.

Hundreds of houses in Lorain were damaged by having parts of the roof or the entire upper story blown away. Church steeples and roofs also were extensively destroyed. Most of the business buildings of Lorain were two- or three-story brick structures with here and there two-story frame buildings, some with brick fronts. These generally had the roofs and upper stories blown off. An examination made by the state building commissioner suggests that with few exceptions the damaged buildings could be restored by rebuilding above the first story if originally two stories high, and above the second story if originally three stories high. There were no large stone buildings in Lorain except the federal post office; and this, while on the main street, was not directly in the ruined section. There were no concrete buildings of any size in the path of the storm.

The most important buildings damaged were the State Theater and the municipal bathing beach pavilion and bath-house. The former was entirely destroyed, with great loss of life. The theater was of brick construction, with steel balcony and roof. Adjoining was a mercantile building one story higher, of brick and wood-frame construction. The roof of this building was lifted off, and part of the wreckage fell on the theater roof. Collapse of the theater roof and balcony under this load resulted in twenty to twenty-five deaths.

At the municipal bathing pavilion the entire upper part of the structure was blown away, but the lower part resisted and the occupants were saved. A number of bathers were drowned, however.

Lorain has comparatively few high buildings, and none of them were in the path of the storm except a new steel-frame hotel building, the Antlers. Part of the roof cornice of this building was torn off, but the building otherwise remained uninjured; the trees in the square in front of the hotel were entirely destroyed by uprooting or breaking off.

The steelworks south of Lorain were outside of the tornado path and did not suffer damage. At the shipyard in the northern part of the city, however, much property was destroyed. The Black River bridge on Erie Ave., near this point, had its wood-block paving completely torn out by the wind and blown away. An ore unloading bridge was overturned. Three high modern chimneys, two of brick and one of concrete construction, were destroyed, breaking off apparently with shear or torsion breaks.

Roofs of houses in many cases had one side blown outward. In some parts of the city the trees were stripped and their branches broken off quite uniformly at a level about 15 ft. above ground, and the damage to houses in many cases also indicated that the destructive effect was exerted chiefly above the second-floor level.

The country in the vicinity of Lorain is flat, with no hills to deflect the storm or break the force of the wind. The low height of the buildings in the city also favored the sweep of the wind northward to the lake. The

Houses destroyed by tornado

Wreckage inside State Theater, after roof was crushed in by falling debris from roof of building alongside.

Many buildings were damaged only in the roof and upper story. Suction effects were often observed.

Trees stripped and upper parts broken off without uprooting or breaking trunk

Along Broadway, Lorain's main business artery.

How Lorain Was Devastated by the Tornado of June 28—Eight Typical Views

newer residential district of the city along the lake suffered the worst damage, houses being destroyed for blocks.

Just before the storm the local lighting company turned off the current at its central station. Water and gas both were turned off as soon as the tornado arrived. These precautions and thorough fire guarding immediately after the storm prevented outbreaks of fire.

While the destroyed area represents only a small part of the total city area, it includes the entire business section. Reconstruction of the city, therefore, is likely to give opportunity for extensive city planning. It is expected that the district, which grew up as a development of a business street of a small lake town turned into a larger city by the coming of steel mills from Pennsylvania in the early nineties and a large shipbuilding plant later, will be changed into a modern city composed of buildings of a high type.

Ohio Requires Wider Road Bridges on 1924 Work

Increase in Width from 20 and Occasionally 24 Ft. to 24 and 28 Ft., Respectively, Required—Costs Compared

By W. H. Rabe
Chief Designing Engineer of Bridges, Department of Highways, Columbus, Ohio

WIDER bridges are being called for in the 1924 specifications of the Ohio Department of Highways and Public Works. Standard road widths are 16 and 18 ft., with 5-ft. earth shoulders. Curves are widened. It is the practice to provide a traffic bound surface on shoulders for at least one or two feet next the pavement on each side. With these standard roads the new specifications call for bridge widths as follows:

Full width of roadway 26 to 28 ft. for spans up to 9 ft. For spans of 9 to 40 ft. the minimum is increased to 24 ft. from the present 20 ft. For spans of 40 to 60 ft. the standard width is made 24 ft. and a width of 20 ft. will be an exception, whereas heretofore the reverse has been the rule. For spans 60 to 100 ft. choice is permitted between 20 and 24 ft., depending upon the location, whereas heretofore the practice has been 20 ft. and rarely 24 ft. For spans of 100 ft. or more the standard width is 20 ft. as at present except that for special locations it is made 24 ft.

It has not been assumed that a bridge with a clear width of 24 ft. will accommodate three lines of traffic, although in an emergency it will take care of three lines of passenger cars. The purpose of the increase in width from 20 to 24 ft. is to permit future widening of the approach pavement without having a point of contraction at the bridge and to lessen the chance of the collision of a motor car with the truss, girder or railing of a bridge. Tables I and II are the computed increases in cost due to increased widths for various spans and heights of abutments.

TABLE I—ADDITIONAL COST OF 24-FT. ROADWAY COMPARED WITH 20-FT. ROADWAY

Type of Bridge	Clear Span, Ft.	Clear Roadway, Ft.	Height of Abutments, Ft.	Cost Complete	Increase of 24 Ft. Roadway Over 20 Ft.	P.C.
Concrete slab	9	20	7.42	$780	$90	11½
	9	24	7.42	870		
	9	20	14.42	2,370	200	8½
	9	24	14.42	2,570		
Concrete slab	20	20	7.87	1,300	170	13
	20	24	7.87	1,470		
	20	20	14.87	2,880	290	10
	20	24	14.87	3,170		
Concrete deck beam	40	20	10	3,940	610	15½
	40	24	10	4,550		
	40	20	20	9,040	960	10½
	40	24	20	10,000		
Concrete through girder	60	20	10	5,690	930	16½
	60	24	10	6,620		
	60	20	20	10,840	1,280	12
	60	24	20	12,120		
Steel truss with concrete floor	88	20	10	8,460	1,690	20
	88	24	10	10,150		
	88	20	20	13,610	2,040	15
	88	24	20	15,650		
Steel truss with concrete floor	123	20	10	13,200	2,600	20
	123	24	10	15,800		
	123	20	20	18,400	3,000	16½
	123	24	20	21,400		

TABLE II—ADDITIONAL COST OF 28 FT. ROADWAY COMPARED WITH ROADWAYS OF 20 FT. AND 24 FT.

Type of Bridge	Clear Span, Ft.	Clear Roadway, Ft.	Height of Abutment, Ft.	Cost Complete	Increase of 28-Ft. Roadway Over 20 Ft.	P.C.	Over 24 Ft.	P.C.
Concrete slab	9	20	7.42	$780	$180	23	$90	11
	9	24	7.42	870				
	9	28	7.42	960				
	9	20	14.42	2,370	400	17	200	8
	9	24	14.42	2,570				
	9	28	14.42	2,770				
Concrete slab	20	20	7.87	1,300	340	26	170	11½
	20	24	7.87	1,470				
	20	28	7.87	1,640				
	20	20	14.8	2,880	580	20	290	9
	20	24	14.8	3,170				
	20	28	14.87	3,460				
Concrete deck beam	40	20	10	3,940	1,220	31	610	13½
	40	24	10	4,550				
	40	28	10	5,160				
	40	20	20	9,040	1,930	21½	970	10
	40	24	20	10,000				
	40	28	20	10,970				

Table I shows the increase in cost of a 24-ft. width of roadway over a width of 20 ft., and Table II shows the increase in cost of a 28-ft. width of roadway over widths of 20 ft. and 24 ft. These tables are based on average unit prices. In estimating the abutment cost the plain, gravity type was assumed. The cost totals include superstructure, wearing surface, railing (when required), approach slabs (except on slab bridges), abutments, excavation, detour bridge and approaches (except on slab bridges), removing old bridge, inspection, state insurance, lights, signs and barriers. By height of abutment is meant the distance from top of curb to bottom of footer.

In Table II no figures are shown for spans greater than 40 ft. because the cost increase of a 28-ft. width of roadway over widths of 20 and 24 ft. grows rapidly for spans greater than 40 ft. and the use of a 28-ft. width for spans greater than 40 ft. is not contemplated except in very special cases. Up to a 40-ft. span, however, a width of 28 ft., more or less, will occasionally be required both on or near sharp curves and on roads subjected to especially heavy traffic.

Greater width of roadway will be required on bridges up to a 40-ft. span than on longer spans for the reason that the shorter span bridges comprise 90 per cent of all bridges and also for the reason that it is possible to provide extra width on 14 bridges of 9-ft. span or 10 bridges of 20-ft. span or 3 bridges of 40-ft. span for the same amount of money that it would cost to provide the same amount of extra width on a bridge of 100-ft. span.

Army Engineers Build Four Seagoing Electric Dredges

Three 1,000-Hp. Diesel Engine Generating Units Operate 800-Hp. Propeller and Pump Motors—All Dredge Movements Controlled from Pilot House

Virtually the latest thought in ship propulsion and dredge operation is exemplified in the seagoing hydraulic dredges here described. Diesel-engine electric power generation and all-electric operation even to the smallest service are combined with direct control from the pilot house of every dredge movement. They are unique products of the dredge designer, and as such are described. Their place in the evolution by the U. S. Engineer Department of the seagong hopper dredge is a subject for consideration after their performance in actual operation shall be known.—EDITOR.

ALL-ELECTRIC operation is the latest advance in the development of seagoing hopper dredges by the U. S. Engineer Department. Four vessels now being built—two are virtually ready for service—have absolutely no steam equipment. Propellers, dredge pump, and auxiliaries are motor-operated. Central control from the pilot house of all dredge operations is another feature. It is believed that the new equipment will bring another decrease in operating costs which have dropped continuously since 1855 until now sand is being taken from ocean bars 30 ft. under water, carried five miles and dumped at a cost under 5c. a cubic yard.

All four new dredges are identical and have the general arrangement shown by Fig. 1. In appearance they do not differ noticeably from an ordinary ocean freighter of the better class as shown by Fig. 2. The hull is steel, built to the requirements of the American bureau of shipping, and is 268 ft. 5 in. long over all and 254 ft. between perpendiculars, with a molded breadth of 46 ft. and a molded depth of 22 ft. 6 in. Equipped, the vessel has a dead weight of 2,000 tons on a draft of 19 ft. 6 in. Its speed is 11½ knots. As ships, the new dredges require no further consideration. Their equipment is chiefly of significance. This embraces power units and motors, dredge pump, dredging ladder and hoppers.

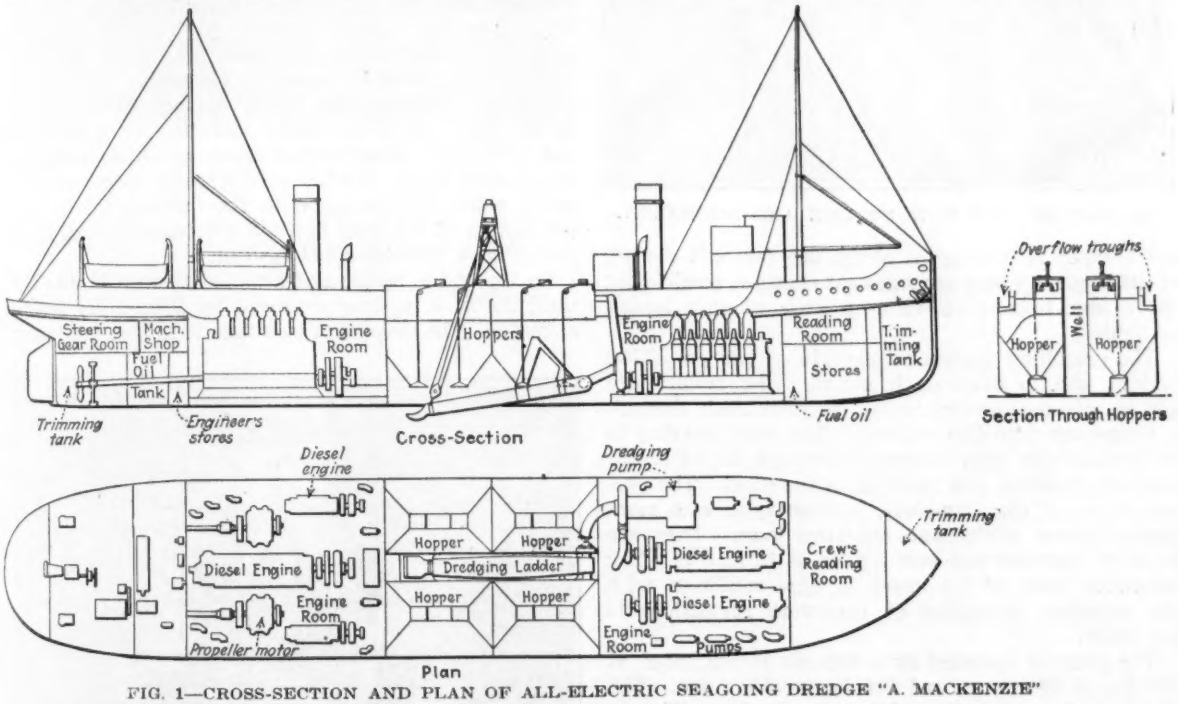


FIG. 1—CROSS-SECTION AND PLAN OF ALL-ELECTRIC SEAGOING DREDGE "A. MACKENZIE"

Engines and Motors—The power units of each dredge consist of three 1,000-hp. Diesel engines, each direct-connected to a 700-kw. 500-volt, generator, and two aux-

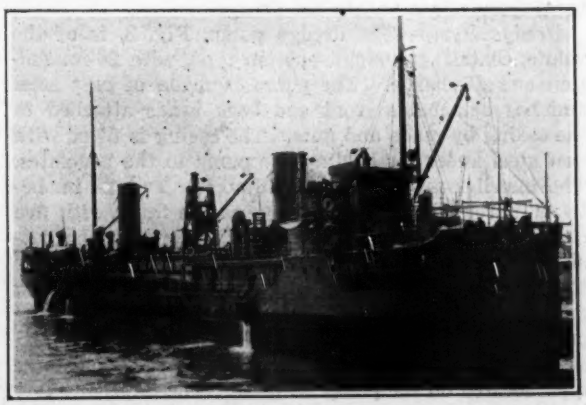


FIG. 2—SEAGOING HYDRAULIC DREDGE "A. MACKENZIE"

iliary 225-hp. Diesel engines, each direct-connected to a 150-kw., 250-volt, generator. The main engines are 6-cylinder, marine type engines, developing 1,000 hp. at 150 r.p.m. The auxiliary engines are 4-cylinder, and develop 225 hp. at 275 r.p.m. The generators are 800-hp. Westinghouse machines. These power units

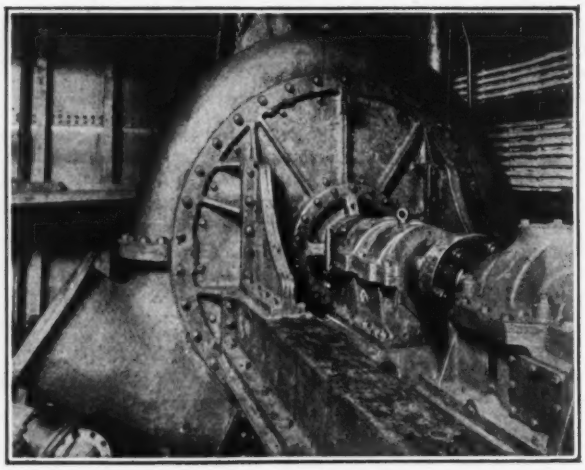


FIG. 3—PUMP HAS 26-IN. SUCTION AND DISCHARGE

are grouped in two engine rooms, one fore and one aft of the hoppers, which arrangement makes it possible for the dredge to rest on an even keel, whether loaded or light.

The propelling equipment consists of two propelling motors, one to drive each screw. The motors are 800 hp. direct-connected to the propeller shaft through a Kingsbury type thrust block. The stern bearing is of the McNabb type, lubricated through an oil feeder running alongside and fastened to the strut. The propellers are of the four-blade, built-up type, with manganese bronze blades and cast-steel hubs. They are 11 ft. in diameter and have a pitch of 12 ft. 3 in. The calculated speed of the vessel, in light condition, with the propellers operating at maximum revolutions is 11½ knots.

The pump is operated by a 480-volt motor, rated at 800 hp. at 156 r.p.m. and 610 hp. at 140 r.p.m. The bearings of the motor are of the self-aligning split type, arranged for ring lubrication. The motor is supported by a cast-iron bedplate, which is bolted to the pump bedplate, both resting on and secured to heavy structural foundations within the dredge.

Dredge Pump—The dredge pump, Fig. 3, is of the volute, centrifugal, single-suction type, with 26-in. suction and discharge. The pump is made of cast steel and has detachable front and back heads attached to the casing by studs and nuts. The casing is fitted with cast steel knees for holding the pump to the bedplates. The impeller is 6 ft. 9 in. in diameter and 13 in. between shrouds at the periphery, and is fitted with five curved interior vanes and ten radial vanes on the outside of the shrouds. The shaft spring bearing is of the sleeve type, having a length of bearing of 24 in., and it is located on the pump bedplate as near to the pump as will permit removal of the pump gland and stuffing box. The thrust bearing is of the Kingsbury type, located on the pump bedplate. The impeller shaft is 10 in. in diameter, and the thrust shaft 8 in. The thrust shaft is connected to the motor shaft by a Francke flexible coupling.

The center of the discharge pipe, at the point where dredged material enters the trough over the hoppers, is 20 ft. 8 in. above the center of pump, and the length of discharge pipe, from pump to hopper trough, is 37 ft. 8 in. At a draft of 13 ft. the center of the pump is 4 ft. 3 in. below the water line.

Dredging Ladder—The dredging ladder is of the box-girder type with 1-in. side plates, ½-in. top and bottom plates, and 6x8-in. 44.2-lb. top and bottom angles. Diaphragms are spaced at intervals to stiffen the ladder and support the 26-in. suction pipe. The guide frames on the ladder consist of a latticed girder, with ¾-in. side plates, ⅝-in. top and bottom plates, and angles and channels.

Cast steel trunnions are fitted at the upper end of the ladder, which are supported by heavy cast steel trunnion bearings connected to the sides of the ladder well. The port trunnion forms part of the suction pipe, which extends to the ladder drag head, and the starboard trunnion is arranged for connection to the jet pump discharge line which extends to the drag. At the lower end of the ladder there is riveted a heavy cast steel head, fitted with flanges, to which is bolted a cast steel drag. On top of the ladder head are two heavy pads for connection to the hoisting gear. At the bottom of the drag is fitted a detachable cast steel grid, Fig. 4, with openings 7½x9 in.

On top of the ladder and attached thereto is fitted a tank, 29 ft. 4 in. long overhead by 4 ft. 6 in. inside diameter. The purpose of this tank is to give buoyancy

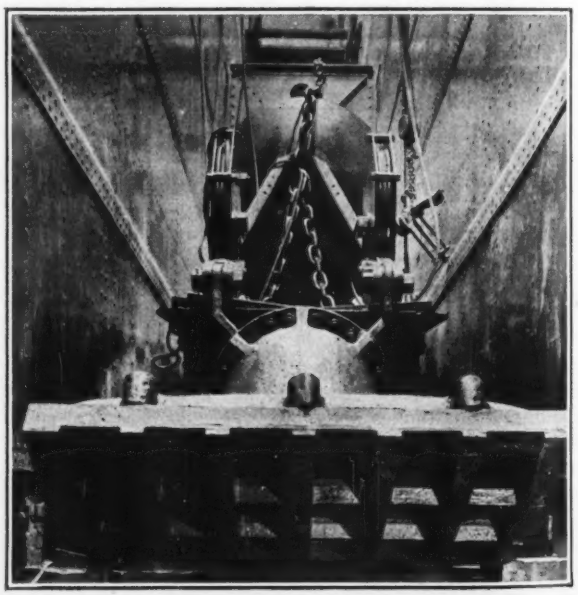


FIG. 4—BOTTOM OF SUCTION PIPE SHOWING DRAG

to the ladder and relieve the pressure to the drag on the bottom of the channel when dredging in soft material, thereby preventing the drag from burying itself to an unnecessary depth. Connected to this tank is a flexible air pipe to furnish compressed air for discharging water from the tank when the latter is required to function.

The ladder is raised and lowered by two three-part,

steel-wire falls fitted with blocks having 30-in. diameter sheaves. The lower blocks are connected to the ladder head and the upper blocks are supported by a structural hoisting frame built over the ladder well. The hoisting frame is fitted with equalizer and coiled springs to take up the shock from the dredging ladder. The hoisting ropes are connected to a double-drum hoisting winch operated through triple reduction gears by a 50-hp. motor located on the same bedplate.

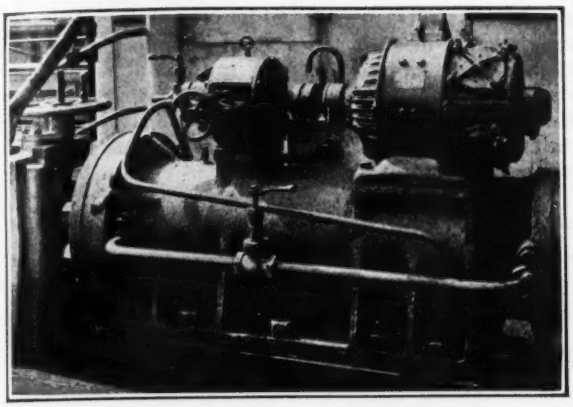


FIG. 5—MOTOR PUMP MECHANISM OPERATES HOPPER DOORS

Hoppers—The dredged material is unloaded through eight openings, two in the bottom of each hopper. These openings are fitted with heavy cast steel frames and swinging doors. Rubber gaskets are fitted in grooves in the doors to insure watertightness when the latter are closed. Each door is connected by a 2-in. diameter rod to a 1⅝-in. chain, the latter operating over an 18-in. sheave supported between two fore and aft girders running the full length of the hoppers. On top of these girders are fitted cast-iron key blocks which form the bearings for the fore and the aft sliding girders.

The door-lifting chains are connected to sliprods, which in turn are connected to the sliding girders by sliprod blocks, thereby permitting the sliprods to move fore and aft.

The sliding girders are constructed of the two 8-in. by 21¼-lb. channels with 12x⅜-in. tieplates spaced at intervals on top and bottom. At the forward end of the sliding girder there are fitted links and crossheads connecting to a shaft which is operated fore and aft by means of a hydraulic cylinder operated by a motor-driven Hele-Shaw pump, Fig. 5. Each cylinder has a capacity of 4,000 lb. raised 43 in. in approximately 1½ min. A locking device is provided with the operating gear which permits the hopper doors to remain closed and at the same time relieves the hydraulic cylinders of any load. Arrangement is also made so that all doors can be operated simultaneously or one or more doors may be cut out whenever the dredge is not operating to full capacity.

The design and equipment as described have been worked out by the U. S. Engineer Department in conjunction with the Sun Shipbuilding & Dry Dock Co., Chester, Pa., the McIntosh & Seymour Corp., Auburn, N. Y., and the Westinghouse Electric & Manufacturing Co.

Design and Construction of Small Concrete-Lined Canals

By W. E. Code
Assistant Engineer, Agricultural Experiment Station, University of Arizona, Tucson

Concluding summary of Bulletin 97, Arizona Agricultural Experiment Station

THE ECONOMY of concrete lining has been proved by many tests. The greatest economy is in the prevention of seepage, but its use, however, should be preceded by seepage tests. Due consideration must also be given to its many other advantages over earth canals, such as reliability and the reduction in maintenance cost.

Linings 1 to 2 in. thick have been used successfully in regions where the frost action is not serious. Present practice tends to make 1½ in. the minimum thickness, but for large canals and steep side slopes, a greater thickness should be designed so as to eliminate inside forms, which materially increase the cost. The use of a 2-in. lining on a small canal having a side slope of ¾ to 1 seems to be the limit in that direction. A steeper slope would require a greater thickness.

Canals located on unstable foundations, such as obtain in miry places and on fills, require strength to resist side and bottom pressure and unequal settlement. Increased thickness, beam effects, and reinforcing will produce the desired results. On fills, especially, the lining should be tight, to prevent saturation of the material of the fill.

Concrete-lined canals should be protected from injury by stock. The growth of trees along the banks should be discouraged, since the roots will force their way through cracks in the lining and eventually rupture it. Gopher holes, next to the concrete, are dangerous because they weaken the foundation. By far the greatest danger is from the entrance of flood water from the sides. Care should be exercised at all drainage ways to provide ample capacity for such waters.

The materials used should be first-class in every respect. Clean sand and water, free from alkali, are especially required.

The cost of 2-in. concrete lining on two Arizona projects was found to be 10½ and 11c. per square foot respectively. This included the preparation of the earth foundation, the cost of materials, and placing of the concrete. The average farmer, with no overhead charges and acting both as foreman and laborer, should be able to apply a 2-in. concrete lining for 9c. or less per square foot, depending a great deal on the price of cement.

Typhoid from Cross-Connection at Everett

A cross-connection between the city water supply system of Everett, Wash., and a lumber mill fire protection water supply plant caused about 2,000 cases of diarrhea and dysentery and 77 cases of typhoid, with two deaths from dysentery and nine from typhoid. According to an account of the incident in *Public Health Reports*, March 28, 1924, as summarized later in *Public Health Engineering Abstracts*, "the unusually low pressure in the city water mains, the lack of an official record of the mill's private fire protection system, and the failure on the city's part to make a plan of the extension to its system before undertaking the new construction, contributed to the re-infection of the city mains" after the water in the city supply had been chlorinated. Although "the disease was very virulent in character," it was "checked within three days after the discovery of the epidemic and one day after the first case of typhoid was reported to the health office." The original article includes a reprint of Washington State Board of Health regulations governing cross-connections, adopted Jan. 14, 1924. The detailed account of the epidemic was written by C. E. Dorisy, state sanitary engineer of Washington.

Grade Separation at Detroit, Grand Trunk Railway

Four-Track Cut in Right-of-Way on Public Street Requires Twenty-two Bridges at Consecutive Streets—City Pays Part

TRACK DEPRESSION instead of track elevation and sharing of expense by both the city and the railroad are notable points in the grade separation work of the Grand Trunk Ry. at Detroit, Mich. The railway enters Detroit by a 60-ft. right-of-way on Dequindre St. from Hale St. to Jefferson Ave., within a short distance of the river, where it makes a right-angle turn to reach the Brush St. terminal station. This separation of grades on the Dequindre St. line has been the subject of controversy and negotiation for several years, partly because the city desired track depression while the railway favored track elevation. An agreement, based on the city's project extending from a point south of Jefferson Ave. north to Hale St., was signed Jan. 16, 1923. Work was started last year and is now in progress on the second season's program. The general situation is shown in Fig. 1.

Elimination of grade crossings at Detroit has been in progress since the construction of the Woodward Ave. subway in 1901, with the result that the elevation of over forty-nine streets has been completed. In addition, fifteen streets are carried over the tracks; of four street viaducts over the Grand Trunk Ry., three are being replaced by structures of a different type. The Jefferson Ave. viaduct was built about 1891 in connection with the opening of East Grand Boulevard. Most of the viaducts were built before 1895 and were not connected with any general plan for grade separation.

Division of Expense—This Grand Trunk Ry. project is notable particularly for the fact that the 1923 contract was the first under an agreement in which the city of Detroit has obligated itself to pay part of the construction cost. In all previous grade separation work at Detroit, the entire cost has been paid by the railroads and even under favorable conditions the expenditures have not exceeded $200,000 annually. But the 1923 contract involved an expenditure of approximately $560,000 and it is anticipated that similar agreements will be made with other railroads. No restriction is made in the agreement as to the amount of money the railway company can spend in any one year. It is provided that the work shall progress at a rate of not less than two streets annually and that the entire work as far as Hale St. shall be completed by the end of 1933.

Except where special provision is made, the city is to pay 25 per cent and the railroad 75 per cent of the cost. All damages to abutting property which are occasioned by the work and result in legal liability are to be assumed by the city. The general plan contemplates the restoration on the new grades of paving, curbing, sidewalks, sewers, water mains, public utilities, tracks, switches and signals substantially as at present. If changes are made by the city in restoring paving, or by the railroad in restoring tracks, any additional cost beyond that of the original facilities is to be borne by the party requiring the change.

The expense of removing and relaying tracks of the municipal street-car lines on five streets will be borne by the city's street railway department. Drainage of all intersecting streets and street bridges will be cared for by the city by the use of its sewers. All public utilities having wires, pipes or conduits across Dequindre St. are required to remove them during the progress of the work. All street bridges and approaches are to be paved with the material now used on the streets; the grading and construction work at bridges and embankments along the street approaches will also be included in the general cost.

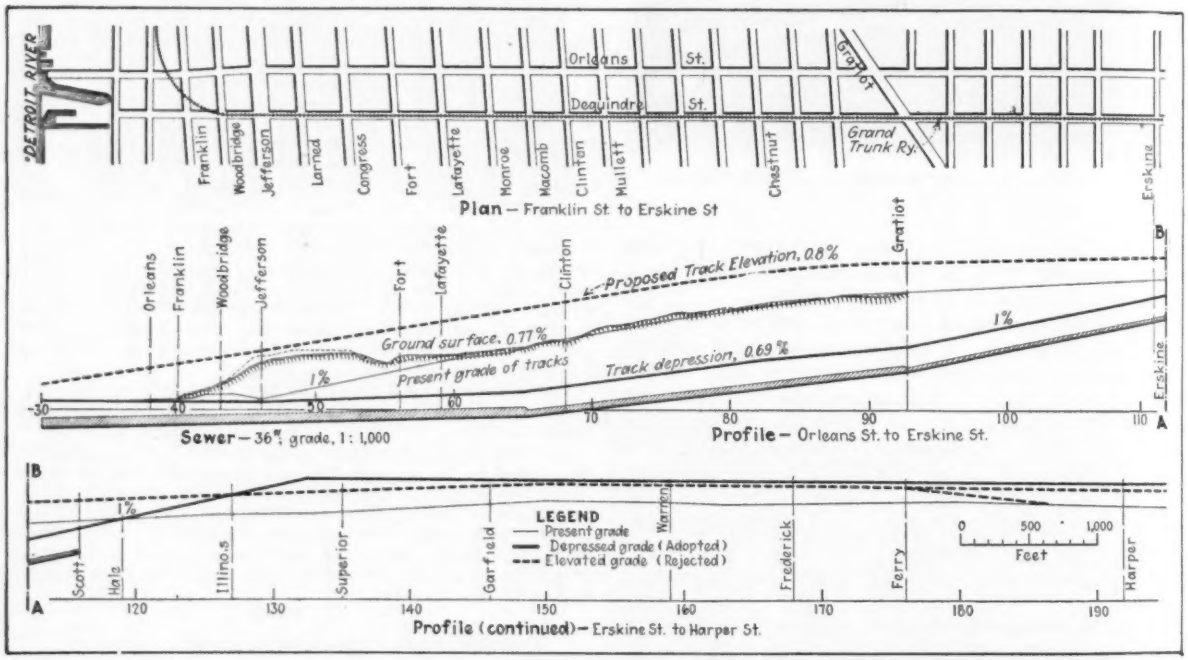


FIG. 1—TRACK DEPRESSION ON GRAND TRUNK RY. AT DETROIT

Grade Separation Plans—In proceedings started by the city against the then Detroit, Grand Haven & Milwaukee Ry. (a branch of the Grand Trunk) for the separation of grades on the Dequindre St. line from Orleans St. north to Ferry Ave., the Michigan Public Utility Commission issued an order finding a public

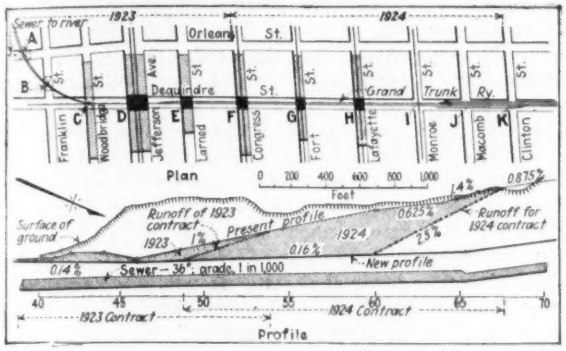


FIG. 2—LAYOUT OF GRADE SEPARATION WORK FOR 1923 AND 1924

A and *B:* grade crossings retained, but slightly changed. *C:* grade crossing depressed. *D* and *E:* new bridges and approaches, 1923. *F*, *G* and *H:* new bridges and approaches for 1924; street car lines abandoned temporarily. *I:* cut 10 ft. deep at end of 1924; street closed till end of 1925. *J:* street closed; cut 6 ft. deep at end of 1924; street to be reopened as temporary grade crossing during winter of 1924-25 and then again closed during work of 1925 season. *K:* Clinton St. not disturbed in 1924, grade of runout track being made steep enough to avoid this street.

necessity for this grade separation and approving the city's plan for the depression of the tracks from Jefferson Ave to Hale St., and for track elevation thence to Ferry Ave.

The company's 60-ft. right-of-way, which is to be preserved at full width, was adaptable for four tracks except between Jefferson and LaFayette Aves. At the Jefferson Ave. crossing the two existing tracks were gantleted, allowing for use of only one track at a time.

The first or 1923 contract covered the work at Woodbridge St., Jefferson Ave. and Larned St. (see Fig. 2). The 1924 program, started April 1, contemplates the continuation northward to include Congress, Fort and LaFayette Sts., which will be restored to use by the end of this year. Railroad traffic, averaging twelve passenger trains and twelve regular freight trains daily, will be handled on a single track that will be shifted within the right-of-way as the progress of the work requires. From Orleans St. there is a short descent at 0.14 per cent to Jefferson Ave., then ascending 0.16 per cent to Macomb St., 0.697 per cent to Chestnut St., 0.5 per cent to Gratiot Ave. and then 1 per cent to intersect the present grade at Hale St. and continue above it to Larned St., beyond which the line is level to the end of the work at Ferry Ave. The entire line is on tangent except for the turn into Dequindre St. at the south end.

With the rather heavy cut along the railroad and the consequent long approach on a grade commensurate with practical operating conditions, there will be two additional streets closed to traffic at some period in the course of operations and these will have to remain closed for a greater period than one construction season. The two streets affected this year are Monroe and Macomb Sts. In order to minimize disturbances to street traffic, by not closing Clinton St., the railway agreed to operate its temporary runoff from the new elevation on a grade slightly steeper than 2.5 per cent (see Fig. 2). The closing of five adjacent streets for eight months and upwards will not occasion undue hardship, as the streets are of secondary importance and not arterial highways as was the case with Jefferson Ave. At most, a detour of three 220-ft. blocks will be necessary.

Temporary street-railway tracks will be constructed on other streets in the locality of the grade separation in progress. At the Jefferson Ave. crossing the street-railway tracks were carried on a temporary structure north of the old viaduct but within the street limits. Half of the street was closed to vehicular traffic during the construction operations and only one-way traffic was permitted, other traffic being detoured on streets one and two blocks north. Streets south of Jefferson Ave. will cross the railway tracks at the new elevation of rails, as shown in Fig. 2, and will have approach grades not exceeding 3 per cent. A 36-in. concrete pipe sewer will extend along the right-of-way from Hale St. to south of Jefferson Ave., where it will connect with an existing trunk sewer along Orleans St. to the river.

Street Bridges—There will be twenty-two bridges for consecutive streets over the 60-ft. right-of-way. Most of these structures will have two 30-ft. I-beam spans supported by abutments and a central bent. The Jefferson Ave. bridge, at the bottom of Fig. 3, is of this type. For the other bridges there will be single 60-ft. deck or half-through girder spans, with I-beam or plate-girder floorbeams and I-beam stringers supporting the concrete deck slab. Cantilever brackets will carry the sidewalk slabs. Where the headroom is

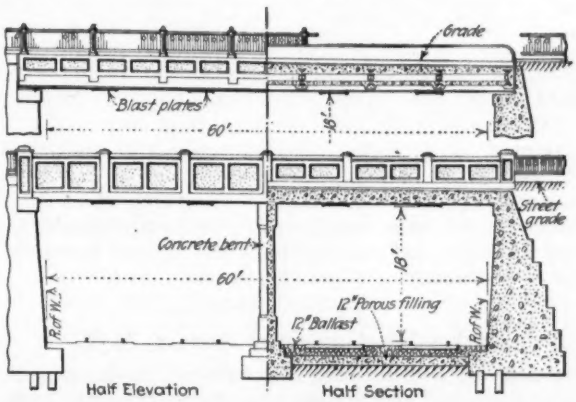


FIG. 3—TYPES OF BRIDGES OVER DEPRESSED TRACKS

insufficient for the deck girder arrangement, the floorbeams will be placed at the bottom chords and the tops of the girders will project above the curb line. All steel will be cased in concrete and blast plates will be placed over the tracks. Typical bridge construction is shown in Figs. 3 and 4, but the floors are modified where street-car tracks have to be accommodated.

Live-load is taken at 100 lb. per square foot for sidewalks and a concentration of 18-ton trucks for the roadways, with an impact allowance of 25 per cent in both cases. Each truck is assumed to have 10-ft. wheelbase with two-thirds of the load on the rear axle, and to occupy a space 25x9 ft. Where street-car tracks are carried, the design provides for a series of 50-ton cars 50x10 ft., with trucks spaced 30 ft. c. to c. and

a 5-ft. truck wheelbase. In this case, the impact allowance is 50 per cent. The depth from top of pavement to clearance line is 3 ft. with short spans and center bent; with single spans having half-through and deck girders, the depth is 4 and 6 ft. respectively.

Bridge abutments and retaining walls are of gravity type with plain concrete 1:2½:5 and a minimum of 1.3 barrels of cement per cubic yard. For the railings and

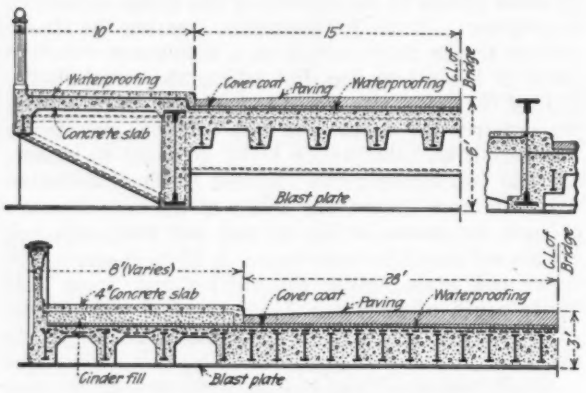


FIG. 4—FLOOR CONSTRUCTION OF BRIDGES
Above: plate-girder 60-ft. spans; half-through girder at right. Below: I-beam 30-ft. spans.

bottom four inches of decks the mix is 1:1½:3, with a minimum of two barrels of cement per cubic yard. The balance of the bridge decks, bents, sidewalks and all other reinforced-concrete parts are of 1:2:4 concrete, with a minimum of 1.6 barrels of cement per cubic yard.

Engineers and Contractors—All the work under the 1923 and 1924 contracts is being done by W. E. Lennane, Detroit. The unit prices of the first contract are continued, except that an addition of $1 per cubic yard was allowed for concrete. Joseph L. Barton is engineer of grade separation for the city; George Jerome is city engineer. F. P. Sisson, division engineer of the Grand Trunk Ry., is in charge of the work, which has been under the general direction of T. T. Irving, chief engineer, who has been transferred to the Central Region of the Canadian National Railways and is now succeeded by J. A. Heaman.

Harbor Development at Oswego, N. Y.

Facilities for handling lake-and-rail business have been completed on the dock property of the New York, Ontario & Western Ry. at Oswego, N. Y., and arrangements made with the Rutland & Lake Michigan Transit Co. to provide adequate shipping service for lake ports. The railway company's annual report for 1923 states that this is one of the initial steps to make Oswego a real port, anticipating the enlargement of the harbor facilities, for which application is now pending before the U. S. Board of Engineers. The route from southern New England to Oswego by the New Haven road and the Ontario & Western is said to be more favorable than any other, so that a fair share of traffic can be developed on that route as well as from New York. For the improvement of Oswego harbor, effort is being made by the city authorities, aided by the rail and lake lines and also by the New York state officials interested in the barge canal terminating at Oswego and the extensive storage and other facilities provided there by the state.

Rules Prohibiting Cross-Connections in State of Washington

CROSS-CONNECTIONS between public water-supply systems in the state of Washington and any other systems of water supply after Jan. 1, 1927, and prior to that date except under conditions noted below, are prohibited by regulations adopted by the State Board of Health on Jan. 14, 1924. The regulations seem to have been prompted by the outbreak of diarrhea, dysentery and typhoid fever at Everett, Wash., noted briefly on p. 59 of this issue, and commented on editorially in this issue, p. 46. The regulations require all cross-connections to be discontinued by April 15, 1924, unless both supplies and the connections between them are approved by the State Department of Health. Between the date named and Jan. 1, 1927, cross-connections will be permitted if protected by double check valves. After that date no public water supply may be used for "fire protection" by any means of direct connection with a private water-supply system.

The regulations in full are as follows:

WASHINGTON STATE DEPARTMENT OF HEALTH

Regulation Prohibiting Water Cross-Connections

Section 70 (k). For the purpose of this regulation, a cross-connection is a physical arrangement whereby a public water-supply system is connected with another water-supply system, either public or private, in such a manner that a flow of water into such public water-supply system from such other water-supply system is possible.

(l) For the purpose of this regulation, a bypass is a physical arrangement whereby water may be diverted around any feature of the purification process of a public water supply.

(m) For the purpose of this regulation, an emergency intake is an intake or other device capable of introducing water into the public water system from a source of supply which, because of its unsafe characteristics, has not been approved for drinking and culinary purposes by the State Department of Health.

(n) All cross-connections are hereafter prohibited within the limits of the State of Washington unless both water supplies are of safe sanitary quality, and both supplies and the connection thereof have received the approval of the State Department of Health. All persons, firms, or corporations now having or maintaining any cross-connections as defined in paragraph (k) of this section, whether or not such cross-connections are controlled by automatic devices such as check valves, or by hand-operated mechanisms, such as gate valves or stop cocks, which may or may not be sealed, shall, on or before April 15, 1924, discontinue and physically separate all such cross-connections, unless both supplies and the connection thereof have received the approval of the State Department of Health.

(o) Failure on the part of persons, firms, or corporations to discontinue the use of any and all cross-connections and to separate physically such cross-connections before April 15, 1924, will be sufficient cause for the discontinuance of the public water service to the premises on which the cross-connections exist, unless the quality of the water from the two supplies used has been approved by the State Department of Health. *Provided*, that, in the case of persons, firms, or corporations having installed before April 15, 1924, cross-connections consisting of two gate valves with indicator posts, two check valves of the factory mutual type with drip cocks and gages for testing, all to be placed in a vault of watertight construction accessible to ready inspection; the date of discontinuance of the same shall be extended until Jan. 1, 1927: *Provided further*, that such cross-connections are subjected to such inspections as the State Department of Health deems proper, the expense of such inspections to be borne by the person, firm, or corporation using such a cross-connection.

(p) After Jan. 1, 1927, public water supplies shall be made available for fire protection by the following methods only: (1) Construction of a pump well, or reservoir, to which the city mains are connected, pumps taking suction

from well or reservoir and pumping to an elevated tank for storage and pressure; or (2) an elevated tank or standpipe supplied at the top and above the overflow by a connection from the city main. Such tank or standpipe may then be connected to the fire-protection system; or (3) two independent systems or piping without any connection whatsoever, one being supplied from the city mains and the other from the independent water supply.

(q) No bypass shall be established or maintained whereby water may be diverted around any feature of a purification process of a public water-supply system, provided that with the specific approval of the State Department of Health, bypasses may be permitted around primary sedimentation basins, aerators, or mixing chambers.

(r) No emergency intake as defined in paragraph (m) of this section shall be established or maintained in connection with a public water-supply system.

Steel Viaduct Built Under Traffic Replaces Old Timber Spans

Howe Trusses Built in 1873 Removed Because of Fire Danger—Viaduct Erected Inside Old Bridge

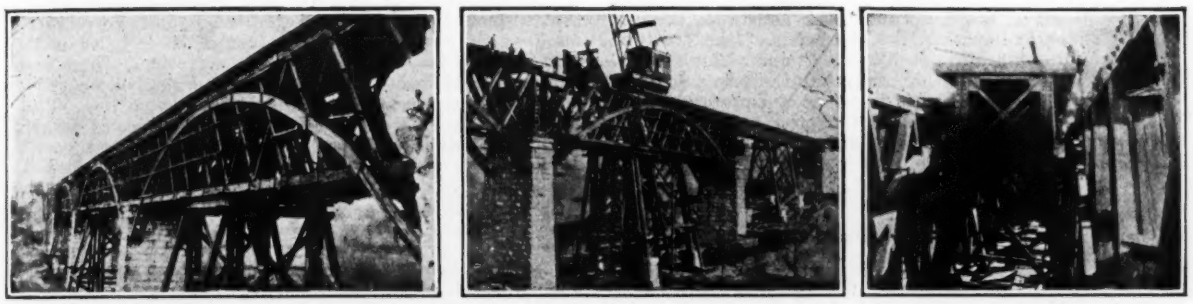
A FIFTY-YEAR-OLD Howe truss bridge on a Virginia R.R. line was recently removed and replaced by a modern steel viaduct without interruption of traffic. An interesting feature of the case is that the material in the old structure was still in excellent condition. A few members had previously been renewed, because of local deterioration, but practically all the original timber remaining at the time of removal was salvaged for further railroad use, as for repair work around stations. The engineer in charge of the work, H. C. Libby, engineer of bridges of the Southern Ry., Lines East, at Charlotte, N. C., attributes the excellent preservation of the old woodwork partly to the protection of the structure from weather by sheathing and partly to the excellent carpenter work done in framing the original trusses.

Originally there were six crossings on the Harrisonburg branch of the Southern Ry., in Virginia, composed of wooden Howe-truss spans. All of them were built about 1873. They had from two to four spans, 90 to 120 ft. long. Since 1915 two of these structures have been destroyed by fire, each case causing several days' traffic interruption. Following the second fire, in 1922, it was decided to replace the other four crossings as rapidly as money could be provided. The longest of them, the Toms Brook bridge, consisted of four 120-ft. spans with a maximum height from base of rail to ground of 65 ft. This is the structure shown in the accompanying views. The trusses were about 15½ ft. deep and were spaced about 13 ft. 9 in. apart on centers or 11½ ft. in the clear. The floorbeams were 10x14-in. timbers.

To avoid the expense of falsework in carrying out the replacement it was decided to design a new deck-plate girder viaduct which could be erected inside the old trusses. This viaduct was laid out with 30-ft. tower spans in the middle of the old truss spans, and 48-ft. intermediate spans from these towers to the old piers, which were retained. The girders were spaced 6 ft. 6 in. apart. In advance of steel erection, the old piers were topped with concrete to the new bridge-seat elevation, and pedestals for supporting the viaduct bents were built.

The steel viaduct, designed for Cooper's E60 loading, was built and erected by the Virginia Bridge & Iron Co. The towers were erected by a crane operating on the old track, working through the floor, without interruption of traffic. After the towers were in place the superstructure erection was carried out for the length of one of the old spans at a time. Track was cut between trains, the floor system and top bracing of the trusses removed, and the three new plate girder spans set in place. As soon as track was restored on the length of this span, traffic was resumed. The average time required for the replacement of one span in this way was about 3 hr. When the entire length of the new viaduct was in place, the old trusses were dismantled and the masonry work of the new pier tops was completed. Except for the placing of the tower steel the erection loads were carried entirely by the new structure, the successive spans being handled and set in place by a locomotive crane working at the forward end of the span last placed.

From the views it may be seen that the old trusses were fitted with reinforcing arches and with midspan supporting towers. The timber reinforcing arches were placed about 1898, for reasons not known today. Ten years later the structure was strengthened to carry heavier locomotives; the towers were placed under the spans, additional counters inserted to distribute the load to these towers, and about two-thirds of the old top chord replaced with new long-leaf yellow pine sticks. The material of the original structure was white pine, and except for these replacements it was still found in good condition when the old spans were finally taken down. The arches were connected to the old trusses by suspension rods, which were so adjusted that the arches carried practically all the dead-load. The material in the old spans included about 300,000 ft. b.m. of timber and 260,000 lb. of iron rods and castings.



WOODEN RAILROAD BRIDGE FIFTY YEARS OLD REPLACED BY STEEL TRESTLE UNDER TRAFFIC

Toms Brook crossing, Southern Ry. During its active service the structure was protected from the weather by wooden sheathing on sides and top. The view at the left shows the bridge when this sheathing had been removed.

New Facts on Steel, Cement, Brick and Paint

Notes and Abstracts of Papers from Meeting of American Society for Testing Materials, Including Symposium on Rustless and Stainless Steels and Studies of Effect of Calcium Chloride and Sulphates on Concrete

Proof-Testing Causes Brittleness in Chain Links

TROUBLE from brittleness in large-size chain was investigated at the Boston Navy Yard recently, as stated in a paper by C. G. Lutts at the meeting of the American Society for Testing Materials, at Atlantic City. Both service failures and failures resulting when chain links were dropped on an anvil evidenced such brittleness. A special study was made to determine whether the proof strain applied to chain (60 per cent of the required breaking load) produces brittleness. Most of the specimens in the tests were links of 2⅝ and 2¾-in. metal diameter, but a few of 1⅜-in. size were included. The links were partly from new chain and partly from used chain, and one set had been subjected to 150,000 applications of the proof load before the drop test; the others were subjected to a single proof load. The drop test consisted in dropping individual links a height of 16 ft. on a 2,000-lb. solid steel block repeatedly until they broke (with some exceptions).

The drop test results showed that a chain which is proofed once is definitely weakened in resistance to shock. In a particular case the links averaged 31 drops to failure before proofing and 9 drops after proofing; similar general results held for all the tests. Annealing the chain after proofing, however, improved the shock resistance three to fivefold and also improved the character of the fracture. This applied to annealing at 700 deg. C. and at higher temperatures. With the 700-deg. annealing there was no grain growth, and this temperature is considered preferable.

The test data also indicated that the welded ends of these wrought iron links were definitely weaker under shock than the bent ends.

* * *

Cast-Iron Pipe Tests

TWO SERIES of tests of transverse test bars of pipe foundry cast iron were made within the last few years, by Richard Moldenke for a group of pipe manufacturers, and by James T. Mackenzie for the American Cast Iron Pipe Co. Breaking load and deflection tests of 113 bars (2x1x26 in.) as reported by Mackenzie indicated that the deflection increased as the carbon plus one-fourth the silicon. This applies to the deflection at 1,500 lb. load, which was well below the ultimate strengths of the bars. The breaking loads ranged from 1,600 to 4,600 lb., the ultimate deflections from 0.16 to 0.60 in., and the deflections at 1,500 and 1,900 lb. respectively from 0.10 to 0.37 in., and from 0.13 to 0.55 in. The deflections at 1,500 and 1,900 lb. load are much more regular in their inverse relationship to breaking strength than the ultimate deflections, and Mr. Mackenzie accordingly recommends that specifications for cast iron for pipe should fix a minimum deflection of 0.25 in. for deflection at 1,900 lb. load, in place of the ultimate deflection as is common at present.

Mr. Moldenke found that 294 test bars from eight foundries ranged in ultimate strength from 1,850 to 2,650 lb. (group averages), with an average of 2,236, and in ultimate deflection from 0.31 to 0.42 in., with an average of 0.36. Under a specification clause that has been proposed, to require 0.30-in. deflection at 1,900 lb., 68 per cent of the test bars would have been excluded; under the requirement of 0.25-in. deflection at 1,900 lb., 49 per cent of the bars would have been rejected. Tests of arbitration bars, 26 sets with a total of 299 bars, showed an average transverse strength of 3,265 lb. and an average deflection of 0.10. Assuming that a specification to be fair to this commercial material should pass 75 per cent of all the test bars included in the tests, he deduces that the minimum deflection at 1,900 lb. should be fixed as 0.22 in. Further research in tests of cast iron and tests of pipe is suggested, to be conducted by a joint committee of engineers and manufacturers.

Resistance of Stainless Steel to Sea Water

TESTS of thirty commercial corrosion-resistant steels under sea-water spray exposure were made by Jerome Strauss and J. W. Talley for the U. S. Naval Gun Factory at Washington. The materials tested were of three types: Hardenable chromium steels, non-hardening chromium steels, and steels having mainly nickel content. Of the hardenable steels, none was found totally proof against sea-water spray. All far excelled carbon and ordinary alloy steels, but all developed rust regardless of the heat treatment, and some pitted badly. The non-hardening steels may be used where a thin film of rust is acceptable or where frequent cleaning is possible. A steel with 22 per cent chromium and 1 per cent carbon sometimes showed absolute immunity in 500 hr. exposure, as did also one high-nickel steel with chromium and copper. All the steels have low proportional limit ratios, and proper heat treatment must be used for the hardening types of chromium steel.

* * *

Metals Resistant to Mine Water

FROM extensive tests made by the U. S. Bureau of Mines, Robert J. Anderson and George M. Enos report that while ordinary iron and steel are rapidly corroded by mine water, five or six metals (out of 45 included in the tests) have a very high resistance to corrosion. These were a high-chromium steel, two chromium-nickel-silicon steels, a high-silicon cast iron, and a nickel-chromium iron. Electrolytic corrosion tests on all the materials showed roughly the same order of resistance as the immersion tests.

The acidity of coal mine waters is due to sulphuric acid produced by oxidation of iron sulphides associated with the coal; in a typical mine water about 11,000 parts SO_4 per million may be expected. Neutralization of the water is considered out of the question, and saving can be made in the replacement of pump parts and pipe lines only by the use of suitable corrosion resisting materials. Protective paints are widely used and are of considerable service for protecting parts where abrasion or strain does not break the paint coating.

The essential elements of composition of the metals found resistant to the mine waters are given below. The first group, ferrous alloys, showed a corrosion loss ranging from slightly over 0.0001 to 0.004 mg. per sq.cm. in 24 hr., while the non-ferrous alloys showed losses ranging from 0.003 to 6.7 (rolled monel metal).

Ferrous Alloys

High-silicon cast iron, C 0.76, Si 13.8.

Rolled high-chromium steel, C 0.36, Si 0.53, Mn 0.27, Cr 29.5.

Rolled chromium-nickel-silicon steel, C low, Si 3.40, Cr 12.96, Ni 23.87.

Another rolled chromium-nickel-silicon steel, C low, Si 3.26, Cr 10.73, Ni 29.60.

Cast chromium steel, C 0.65, Si 1.0, Mn 0.35, Mo 0.75, Cr 18.0.

Rolled chromium steel, C 0.09, Si 0.87, Mn 0.11, Cr 13.37.

Non-Ferrous Alloys

Cast lead bronze, Cu 89.8, Sn 9.7, Pb 0.5.

Cast lead zinc bronze, Cu 86.34, Sn 11.24, Pb 0.83, Zn 1.60.

Cast lead bronze, Cu 74.9, Sn 10.5, Pb 14.3.

Another cast lead bronze, Cu 87.5, Sn 10.6, Pb 1.6.

Rolled complex bronze, Cu 89.8, Sn 5.6, Pb 4.6, P trace.

Rolled monel metal, Ni 65.1, Cu 30.5, Fe 4.2.

Rolled nickel, Ni 99.

Cast pure lead, 99.99.

Cast nickel-chromium-tungsten alloy, Ni 60, Cr 20, W 20.

Rolled nickel-chromium-iron alloy, Ni 57.44, Cr 9.37, Si 0.55, Mn 1.75, Fe remainder.

Accelerated Corrosion Tests of Metals

IN THE ATTEMPT to get rapid comparisons of the relative corrodibility of different metals in mine water, experiments at the Bureau of Mines with air bubbled through the test liquids did not give higher weight losses than obtained in long-time immersion tests, R. J. Anderson and G. M. Enos reported. An electrolytic test was then arranged, in which the test sample was the anode and a platinum wire was the cathode, and current with a density of 0.18 amp. per sq.dm. of anode area was passed through the corroding liquid. The anode was continuously rotated, and the run was continued until a weighable loss was obtained. With mine water as electrolyte and ordinary bronze as anode, sufficient loss could be obtained in 8-hr. runs. Comparisons of this test method with long-time immersion tests in acid mine water were carried out with 42 metals and alloys. The results showed that the order of losses in both tests was the same, and that roughly the electrolytic test was about ten times as rapid as the simple immersion test.

Specific observations made included the following: Alloys of the brass and bronze type corroded very uniformly, and the bronze alloys less than the brasses. Cupro-nickel alloys corroded uniformly, about as much as the brasses. Nickel silver alloys showed higher loss, but also uniform, while aluminum alloys, with smaller weight losses, had a tendency to pit quite badly. Rolled "rustless" steel showed the smallest amount of corrosion. Nichrome ranked lower in the accelerated test than in the long-time immersion test, but the other materials ranked in the same order in both tests.

* * *

Two High-Strength Corrosion-Resistant Steels

TWO special steels which had been subjected to elaborate tests of strength and corrosion resistance were reported by B. Strauss, of the Krupp Co. Their compositions are: martensitic steel, C 0.15, Cr 14, Ni 1.8; austenitic steel, C 0.25, Cr 20, Ni 7. In air exposure, sea water, 10 per cent nitric acid, and 50 per cent boiling nitric acid, the corrosion of these steels, and particularly of the austenitic steel, ranged from less than a tenth down to one hundredth and less of the corrosion of high-nickel steel, which in turn was in nearly every case far below the corrosion of ingot iron. In fact the austenitic steel showed no corrosion loss whatever in air and nitric acid exposure, and only very slight corrosion in sea-water exposure. The steels, described as "rust-proof" steels, have been put to a number of different uses. Their strengths range from 90,000 to 130,000 lb. per sq.in. ultimate tensile strength, with 64,000 to 100,000 yield point, and elongation 12 to 22 per cent for the martensitic type, and slightly lower yield point (42,500 to 54,000) and much higher elongation (about 50 per cent) for the austenitic type. The hardness and toughness of the material is high; their wear resistance is about equal to that of 12 per cent manganese steel. Some of the steels are also readily welded by flame or electric arc.

* * *

Properties of High-Chromium Iron

AN IRON alloy with 25 to 30 per cent chromium and fractions of 1 per cent of silicon and manganese, with varying amounts of carbon from 0.1 to 3 per cent, has been studied quite fully at the Union Carbide & Carbon Research Laboratories (Long Island City, N. Y.), and the results are reported by C. E. MacQuigg. In the whole range of carbon content the material makes excellent castings, but for ease in machining the carbon should not generally exceed 1.5 per cent. Castings have a high degree of toughness. Even higher carbons may be made machinable by suitable heat treatment. The alloy also has a satisfactory forging, pressing, and rolling quality. The resistance to oxidation of all kinds is great, as for all chromium alloys, and appears to depend almost wholly on the chromium content. Above 20 per cent, the alloys are noticeably superior in oxidation resistance to those below. Alloys with 26 to 28 per cent chromium remain good indefinitely when exposed to oxidizing atmospheres up to 2,100 deg. F. or higher; they accumulate a thin, tough adherent scale of oxide which is more like an enamel than a scale, and this appears to act as a protective coating, and in addition resists flaking off. Carbon monoxide and other reducing gases are without effect until very high temperatures are reached, after which they have a deteriorating effect. So long as the atmosphere is oxidizing, the alloys seem to be safe nearly up to their melting point. Sulphur and sulphur gases are without effect up to 1,800 deg. F. Moist mixtures of sulphur dioxide and oxygen acting for several hours at the same temperature produce only light tarnish. The alloys are practically immune toward nitric acid, fruit and vegetable acids, and mine water. Hydrochloric acid attacks the material, as does also dilute sulphuric acid, hot strong sulphuric and hot acetic acid. Seawater resistance is high.

The tensile strength of the material depends on the carbon. With carbon kept low, the elastic limit ranges from 45,000 to 70,000 lb. and the tensile strength from 75,000 to 90,000 lb. per square inch, with ductility up to 35 per cent. Higher-carbon alloys show low ductility and high hardness.

* * *

Ball Bearings of Stainless Steel

WITH a view to making ball bearings rust-resisting, stainless steel was tried as a material for balls and races in some long-time running tests conducted in the Swedish S K F factory by A. Hultgren. The bearings were of the self-aligning type and were run in a bearing testing machine at 1,000 r.p.m. and at varying loads, to determine their carrying capacity; in most tests water was admitted to the bearings, to reproduce regular service conditions. The results showed their carrying capacity to be only about 10 to 20 per cent of that of ordinary ball bearings. In fact the stainless steels were only slightly superior to bronze and far inferior to ordinary hardened chromium carbon steel ball bearings. Properly designed roller bearings of stainless steel may have sufficient carrying capacity to justify their use in cases where non-rusting material is necessary and the load is not too heavy.

* * *

Steels for Air-Craft Engine Valves

McCOOK FIELD tests of various metals for service in exhaust valves of aircraft engines, as reported by J. B. Johnson and F. A. Christiansen, show that no material fills all the requirements. The maximum valve-head temperature in this service is 1,600 deg. F., and the eroding action of the exhaust gases at 150 to 200 ft. per second is high. Tests were made in an 18-cylinder engine operating under full throttle at 1,800 r.p.m. High nickel-chromium steels and monel metal galled on the stem and distorted on the tappet end; 14 per cent chromium steel softened; tungsten steel was attacked by the hot gases. The best results were obtained with a cobalt-chromium and a silicon-chromium steel.

* * *

Accelerated Exposure Tests of Varnishes

SEVEN varnishes were tested in the laboratory of the New Jersey Zinc Co., Palmerton, Pa., by accelerated weathering under exposure to a quartz mercury arc lamp, water spray, and refrigeration at —30 deg. C.; exposure was either continuously to any one of these actions, or in 3 to 18 hr. alternations of two or more of them. An outdoor sun exposure was run as a check. H. A. Nelson and F. C. Schmutz reported the results.

The varnishes ranged from mixing varnishes to rubbing and automobile finish varnishes, with various gums and with both tung and linseed oil and combinations of the two. In one set of tests the varnish was brushed on, in the other it was applied by dipping; no essential difference between the results of brush and dipped tests appeared. Cracking and decrease in gloss were recorded. The accelerated exposure tests were roughly checked by the outdoor tests, but not closely; they were concluded to be a good guide in judging of the effect both of raw materials and of manufacturing procedure on the endurance of the varnish. The type of cracking exhibited by each varnish was observed to be

distinctive, some varnishes showing very fine distributed cracking and others a coarse meshwork effect.

Limed rosin as a gum showed a distinctly harmful effect on the varnish, especially in resistance to water, in cases where large amounts of water-resistant oil had not been used. The brittleness of the gum caused weakness to temperature effect. Congo gum had only moderate water resistance, but gave an elastic film. Kauri gum was found especially water-resistant. Tung oil exhibited special virtue in improving the water-resisting quality of the varnish and its resistance to the deadening action of light, being superior in both respects to linseed oil.

* * *

Strength Tests of Brick Walls

RECENT tests of brick walls carried out at the Bureau of Standards, reported by S. H. Ingberg, are summarized in the table herewith. They were made on sections of wall 8 in. and 12 in. thick, and were paralleled by strength tests of the individual brick. Most of the figures for the individual brick represent the average of a number of brick, and each of the wall figures represent several wall tests. The wall strengths obtained are decidedly low for well hardened masonry. The workmanship was of fair commercial quality, the walls having been laid up by an outside mason under contract.

STRENGTH AND SURFACE CHARACTERISTICS AND MASONRY STRENGTH OF INDIVIDUAL BRICK
Tests made at Bureau of Standards on sections of solid 8- and 12-in. walls laid in portland cement lime mortar

Kind of Brick or Clay	Strength of Individual Brick, Lb. per Sq.In.			Absorption, Per Cent	Surface Characteristics	Compressive Strength of Masonry Lb. per Sq.In.	Ratio of Masonry Strength to Brick Strength		
	Compression on Edge	Compression on Side	Modulus of Rupture				Compression on Edge	Compression on Side	Modulus of Rupture
Western surface clay	2,166	2,967	1,155	23.1	Smooth; Die molded; End cut	513	0.237	0.173	0.444
Eastern surface clay	2,497	3,328	824	15.8	Sanded in molds	796	0.320	0.240	0.966
Shale	6,577	8,393	2,121	6.7	Die molded; Wire cut on wide faces	1,538	0.234	0 184	0.725
Concrete	1,486	3,129	641	13.4	Rough; Protruding mortar ridges and aggregate	940	0.633	0.300	1.466
Sand lime I	4,744	4,545	1,142	16.6	Smooth on all faces	864	0.182	0.190	0.757
Sand lime II	1,688	1,840	463	21.0	Rough; Protruding aggregate	830	0.492	0.451	1.794

* * *

End Condition of Concrete Test Cylinders

H. F. GONNERMAN, Structural Materials Research Laboratory, investigated the effect of end condition of test cylinders on the reliability of compression tests of concrete. About 2,800 6x12-in. concrete cylinders were studied, using different mixes of concrete. The most important conclusion from the test is that too great care cannot be exercised when preparing cylinders for test in order to secure ends which are true planes. When the standard method of capping with plain cover plates cannot be followed, the cylinder should be troweled smooth and bedded with gypsum or a mixture of gypsum and cement at the time of test. The cylinder should always be molded on a plane surface. Various observations were made as to the value of different methods of bedding and comparative figures are given in the paper as to the efficiency of these different methods.

* * *

Effect of Aggregate Upon Concrete Shrinkage

CLOYD M. CHAPMAN, consulting engineer, New York, studied the relation of certain aggregates to the shrinkage of concrete following the observation of some serious cracks in concrete floors due to shrinkage, particularly due to the curling up at edges of slabs. Tests were made on pieces 24 in. long, 2 in. square, calipered on end inserts. Conclusions are not given as final because of the incompleteness of the tests, but the author states it is probably safe to say that the investigation indicates the following: (1) The aggregates used in rich mortar mixtures for the wearing or finish course of concrete floors may have a marked effect upon the contraction and consequent cracking of the top. (2) Some aggregates may produce such a degree of contraction as to make their use inadvisable. (3) The contraction of

Calcium Chloride as a Concrete Admixture

DUFF A. ABRAMS, Structural Materials Laboratory, Chicago, reported the results of tests of 7,500 compression specimens made to investigate the effect of admixtures such as calcium chloride and other soluble compounds of a calcium chloride base on the compressive strength of concrete and mortar. Compressive strength tests were made at ages of two days to three years, using admixtures of calcium chloride from two different manufacturers and three proprietary compounds of calcium chloride base. In one series of tests magnesium chloride was included. The results of the tests are as follows:

Calcium chloride and the admixtures containing calcium chloride when used within certain limiting percentages, gave increased strength to concrete.

Magnesium chloride in flake form (46 per cent magnesium chloride, 54 per cent water) when used in concrete caused a reduction in strength except for small percentages, which showed a slight increase for 2- and 7-day tests.

The effect of the calcium-chloride admixtures in concrete varied with the type and quantity of admixture. When the tests are compared on the basis of chlorine content the different admixtures give similar results but not the same numerical values.

Calcium-chloride admixtures of the types used increased the strength of concrete approximately in proportion to the amount used up to a certain "optimum" percentage; the strength increase became less for further additions. Beyond a certain "critical" percentage further additions produced a reduction in strength as compared to similar concrete without admixtures.

The relative effectiveness of the different admixtures when compared on the basis of strength-ratio (the ratio of the strength of concrete containing admixture to that of similar concrete without admixture, expressed as a percentage) for the optimum percentages, is shown by the following strength-ratios, which are based on tests of 1:5.2 concrete of normal consistency cured in the moist room:

Admixture	Strength Ratios for Optimum Percentage					
	2 days	7 days	28 days	3 mo.	1 yr.	3 yr.
Commercial Calcium Chloride A.	170	125	110	112	117	118
Commercial Calcium Chloride B.	147	124	109	109	119	116
Standard Cal.	151	123	107	107	121	119
Low-Chlorine Cal.	143	118	101	104	113	111
Vitriflux	138	115	106	108	109	114

The addition of calcium-chloride admixtures in amounts less than the "critical" percentage produced an increase in concrete strength that was practically constant at all ages. This constant strength increase, when expressed as a percentage of the strength of concrete without admixture, showed a diminishing ratio as the concrete gained in strength with age.

The increase in strength of 1:5.2 concrete due to the addition of 2 per cent of calcium chloride was practically negligible for a relative consistency of 1.50; it increased as the water content was reduced. For relative consistency 0.90 the strength increase was about 550 lb. per sq.in. For the consistencies ordinarily used in practice (1.10 to 1.25), the increase in strength was about 100 to 200 lb. per sq.in.

The tests confirm the relation between water-cement ratio and compressive strength pointed out in other publications of this Laboratory. The water-ratio-strength

curves for 2 per cent of commercial calcium chloride were similar in form to those for plain concrete but divergent at the lower water ratios, showing the greater effect of the calcium chloride on the richer mixes and drier concretes.

The effect of commercial calcium chloride on the strength of concrete cured under different moisture conditions at normal temperatures was slightly greater in concrete cured in the air of the laboratory than in concrete cured in water or in the moist room.

For concrete cured out-doors at temperatures near freezing, the use of 3 per cent of calcium chloride produced about the same strength increase as for other curing conditions. This strength increase appears as a much higher percentage gain when compared to the low strengths attained for out-door curing.

The time of setting of the cement used was shortened by each of the admixtures. Flash set was produced by most of the admixtures when used in percentages somewhat in excess of those found to give greatest strength increases in concrete.

The important conclusion from these tests may be summarized as follows:

In the use of calcium chloride no advantage was gained for percentages of the commercial product greater than 2 or 3 per cent, corresponding to a chlorine content of 1 to 1½ per cent. This amount when used in mixes of about 1:5 and in consistencies suitable for building construction showed an increase in strength of from 100 to 200 lb. per sq.in. For richer mixes and drier consistencies the strength increase was greater and for leaner mixes and wetter concretes it was less.

* * *

Effect of Coal on Concrete Strength

I. F. MORRISON and H. R. Webb, of the University of Alberta, Alberta, Canada, investigated the effect of finely divided lignite coal on the strength of concrete. Certain sands in the Alberta district contain small quantities of finely divided lignite coal and such sands give a very dark color under the standard colorimetric test, which, under the provisions of that test, would disqualify the sand for concrete. The tests show that small amounts of finely divided lignite coal lower the strength of concrete up to periods of one year. The amount of coal for which the effect was observed was only 0.05 per cent by weight of sand. The effect of amounts of this coal greater than 0.05 per cent is not appreciably more than for 0.05 per cent up to amounts of 1.0 per cent by weight of sand. The decrease in strength is about 8 per cent for 0.05 per cent of coal and is not comparable to the decrease in strength due to the presence of organic acid as indicated by the colorimetric test. Therefore, the colorimetric test cannot be taken as a criterion of inferior quality for sand containing small amounts of lignite coal.

* * *

Concrete Behavior in Sulphate Solutions

NORTON G. MILLER, senior drainage engineer, United States Department of Agriculture, reported the laboratory investigations of the influence of curing conditions and various admixtures on the life of concrete stored in sulphate solutions as indicated by physical changes. Tests were made on 2x4-in. cylinders of 1:2:3 concrete with maximum size aggregate ¾ in. These were exposed to sodium and magnesium sulphate solutions to stimulate the behavior of drain tile in alkali country. Curing conditions varied. Content of admixtures also varied, calcium chloride, certain colloids, water gas tar, etc., being used. Blast furnace slag was also used as an aggregate. The conclusions of the author are as follows: (1) In the curing of concrete, resistance to attack by sulphate-bearing waters is developed during the drying and hardening period in air and not during the period it is kept moist. (2) Curing in steam in a temperature near 212 deg. F. results in a product very much more resistant to attack than curing in water, all other factors being the same. (3) Additions of ground blast furnace slag, ironite, calcium chloride, and Cal in each case for the quantities used increase the life of the concrete. More investigations are under way with these materials. (4) Additions of a siliceous material in the form of volcanic ash and additions of water gas tar are of very doubtful utility. (5) Results with additions of hydrated lime, a patented colloid, and with water gas tar are negative.

Law Specifies Life of Structures Financed by Bond Issues

ONE of the most important laws relating to the financing of the construction of public works was the Downing law passed by the New York State Legislature of 1924, adding a new section to the state finance law, specifying a definite lifetime for different classes of public improvements. The immediate necessity for the new law was the issue of $50,000,000 of bonds authorized for state hospital purposes and the constitutional provision that bonds issued for such construction shall not run "for a period longer than that of the probable life of the work or the object for which the debt is to be contracted." In a broader sense the specifications contained in the new law afford a working guide for other states and municipalities in financing public improvements.

Under the terms of the statute buildings and appurtenances are divided into three classes: Class A buildings, in which the walls are constructed of brick, stone, concrete, metal or other incombustible material, with life of fifty years; Class B buildings, in which the construction is known as fire-resisting, forty years; Class C buildings, which are in neither class A or B and which are neither fire-proof nor fire-resisting, twenty-five years. The life of plumbing, heating, lighting, power, water supply, refrigeration, ventilating, sewerage or drainage plants or systems, or two or more of them, is placed at twenty-five years. Sewer, water, gas or other service connections from the service main in the road, street or highway to the property line are expected to last for fifteen years.

Roads, streets and highways are divided into three classes: Twenty-five years for a road surfaced with bricks, blocks, sheet asphalt, bitulithic or bituminous concrete, laid on a solid foundation, or of concrete; fifteen years, if the surface is of water-bound macadam or penetration process; seven years if the surface is of sand and gravel. Brick, stone and concrete sidewalks are given a mortality expectancy of twenty years, while crushed stone, rock dust and cinders are hazarded at ten years. Any other kind of a sidewalk may last seven years.

The life of bridges and culverts is specified at forty years unless constructed of wood and for ten years if constructed of wood. Structures for the elimination of grade crossings, and improvements incidental thereto are given a fifty-year span of life.

So far as is known this is one of the first attempts on the part of a legislative body to establish by statute a "mortality experience table" for public improvements.

New York State Records Highway Progress

The New York State Bureau of Highways reports for the week ending June 20, 175 highway contracts under way with 6,698 men employed by contractors and a maintenance force of 4,678 employed by the state. During the week 230,236 sq.yd. of pavement were completed and during the season 778,259 sq.yd., representing 21.98 miles of completed pavement for the week and 73.58 miles for the season. Oiling throughout all nine divisions of the state highway system is now practically completed and reconstruction work has advanced to the stage where pavement is being laid on seventy-four jobs.

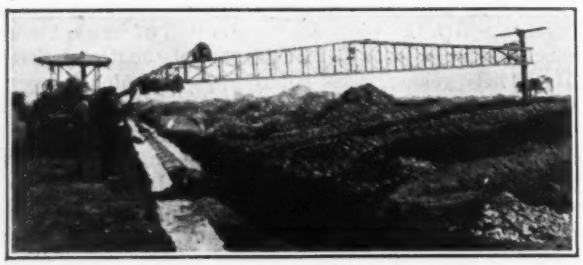
From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Special Backfilling Machine Used on Hetch Hetchy Pipeline

By N. A. Eckart
Chief Assistant Engineer, Hetch Hetchy Project, San Francisco, Calif.

BACKFILLING of the Hetch Hetchy pipeline trench on the Bay Crossing division of the project in Redwood City, Calif., was accomplished by a machine especially designed and built for that job. The laying of the pipeline between Irvington and Pulgas tunnel involved about 12 miles of trench in flat country, where



SPECIAL MACHINE FOR TRENCH BACKFILLING

the soil is deep and ideal for trenching under dry weather conditions. The trench was excavated by draglines, the material being dumped on one side.

Backfilling is done by a piece of equipment essentially a power-operated scraper traveling on an overhead track, the whole moving in the direction of the trench axis under its own power. The equipment consisted of a 75-hp. continuous-tread tractor, which supports one end of a light electric-welded steel truss of 50-ft. span on a swivel bracket, the other end being supported by a pipe column 12 ft. high mounted on a pair of bullwheels operating parallel to the trench on the far side of the spoil bank. This far end of the truss is adjustable as to height by means of tackle, but is normally operated with the lower member about 10 ft. above the ground, the spoil bank reaching a height of 7 to 9 ft.

The drag bucket is made up of ½-in. welded plate; the dimensions are 4 ft. x 5 ft. x 2 ft. The bucket is suspended from a four-wheel carriage by ⅝-in. cables attached to the four corners. The carriage runs on the angles, which form the lower members of the overhead truss. With the attached scraper the carriage is pulled forward under load by means of a drag drum mounted on the tractor and geared directly to the main tractor engine. It is overhauled by a light endless cable which is kept tight at all times by twin drums.

All of the drives, except the drag, are electric, power being furnished by a 15-kw. generator, belt-driven by the tractor engine. There are four motors, one 10-hp. motor operating the twin-drum drive on the pull back, two 7½-hp. motors to raise or lower either end of the bucket, and one 5-hp. to drive the bullwheels in either direction through a worm gear. Power is transmitted to the motors on the bucket carriage by trolley wires mounted on the truss.

In moving the equipment any distance, the truss is swung around behind and carried on an extra pair of wheels mounted on the shaft. About 20 ft. width of roadway is required in moving. In operation the machine will handle about 300 ft. of trench, averaging something over 2 yd. per foot.

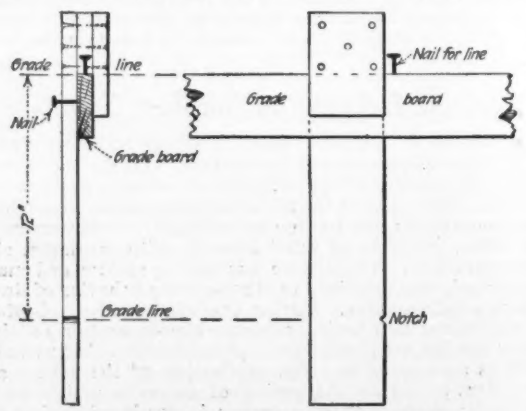
The machine was designed and built by R. LeTourneau, who has a sub-contract on the backfilling under Clifford & Youdall, contractors for trenching and backfilling the entire line. The Western Pipe & Steel Co. furnished and installed the pipe for the city of San Francisco. M. M. O'Shaughnessy, city engineer of San Francisco, is in charge of all the Hetch Hetchy work.

Adjustable Grade Board for Sewer Work

By George E. Wright
Assistant City Engineer, Gloversville, N. Y.

WHERE it is necessary to change the height of the grade board above the grade of the sewer, there is always a chance of error in making the change, and too, considerable time is consumed in looking for a suitable board and then nailing it to the grade board and measuring up or down the required distance. This operation is also apt to disturb the grade board. The device sketched herewith was used by the writer on sewer construction and saved both time and labor.

A piece of 1x4-in. dressed cypress was used. The main part or front board was cut about 20 in. long; then a piece was nailed to one end and then another piece a few inches longer nailed on top of the second piece. This formed a hook which, when slipped over the grade board, held the device firmly in place. To make sure that it did not move up or down, or side-



DETAILS OF A SEWER GRADE BOARD

wise a 6-d. nail was tacked through the main member just enough to catch the grade board. By measuring just 12 in. from the under side of the second piece of board and cutting a notch there, the device became a permanent grade offset.

It was used on the sewer construction work at Gloversville, N. Y., under contract by Frank Sheehan of Albany, N. Y., and in direct charge of the writer under H. J. Hanmer, city engineer.

Construction Organization for Building Transmission Line

By Ole Davidson
Superintendent of Construction, Indiana Electric Corporation, Indianapolis, Ind.

In THE organization of the construction department of the Indiana Electric Corporation for the building of the 74-mile, 132,000-volt transmission line from Terre Haute to Indianapolis, Ind. (see *Engineering News-Record*, May 8, p. 808), there were five departments reporting through an assistant superintendent to a superintendent as follows: right-of-way, engineering, material, construction and accounting. The right-of-way department bought right-of-way and settled construction damages. The engineering department had charge of surveys, maps, profiles, tower locations, sagging of cables and inspection. The material department received all materials, checked invoices for quantities and distributed materials to final locations. The construction department included camp foremen and their operations. The accounting department, in addition to the usual function, included timekeeping, paying, purchasing and commissary.

At each working base there was a representative of each department: camp foreman, timekeeper, material man and engineer. The camp foreman directed organization of his crews and prosecution of the work. The timekeeper not only kept time, but prepared payrolls and distributions, operated the mess hall and commissary and handled small local purchases. The material man had the unloading, checking and distributing of material as needed by the camp foreman. The engineer was responsible for lines and grades for tower locations, knowledge of right-of-way contracts and special conditions, the sagging of the cables and final inspection.

After an analysis of all conditions it was decided to have five working bases, each covering about fifteen miles of line. Two of these bases were at Terre Haute and Indianapolis, and the other three were camps adjacent to the line at strategic points.

At each camp a drilled well was put down to secure a safe and sufficient water supply, varying in depth from 50 to 75 ft. A 3-hp. gasoline engine with pump jack, fitted to an ordinary well pump having 2½x14-in. cylinder, raised the water to a covered wood tank 5 ft. in diameter and 6 ft. high on a 16-ft. tower. The engine also furnished power for a 3x3½-in. air compressor to inflate tires for trucks and cars. In each case the pipe from the pump to the tank was carried overhead so as to be drained easily for cold weather protection. For winter, the supports of the water tank were boarded up and an oil heater placed inside to prevent freezing of the pipes from the tank. At 15 deg. below zero there was no inconvenience.

The buildings erected were an office, 16x42 ft.; a mess hall, 24x60 ft.; latrine, 10x14 ft.; and a bath house, 6x14 ft., all with 8-ft. studs and two-ply prepared roofing. The office was divided into four rooms; bedroom for the timekeeper, time office, commissary supply room and tool room. The construction was single-ply boards covered with single-ply roofing paper. Floors in the office and mess hall were of 4-in. concrete with a troweled surface, which proved a success from all angles, including economy. The mess hall had an 18x24-ft. kitchen in the end nearest the office, the remainder being a dining room.

The kitchen had a large range with water back, a hot water tank, serving table, two cupboards, ice box, meat block and sink. Water was piped from the storage tank to the kitchen. In the dining room, the tables and benches were separated from each other and from the walls, so they could be moved out. This arrangement proved convenient later, when the room was used as a warehouse. In the bath house there were two shower baths, each 4x4 ft. with a 6x6-ft. dressing room.

Wall tents for four men each were 14x14-ft. with floor and fly, the floors being made in sections to facilitate moving if required. For the cold season, 10-in base boards were put around the outside of the floor and inside the canvas and banked. A door frame and a batten door were put in. A cast-iron coal stove furnished the heat, the pipe being carried horizontally through the back gable of the tent and the vertical portion outside supported by a 2x4-in. post set in the ground. Where the pipe passed through, the canvas was protected by a piece of tin 18x18 in. on each side of the canvas.

These tents were set in rows, spaced 22 ft. c. to c. in the row, and were tied to 2x6-in. pieces nailed to fence posts set and anchored in the ground. Cots and mattresses were furnished to the workmen, the blankets being sold. In each case it was necessary to put cinders or gravel on the ground in order to get the motor equipment into the camp site and for parking purposes. The camps were used as storage places for copper, fit-

CONSTRUCTION CAMP FOR INDIANA TRANSMISSION LINE

tings, insulators and miscellaneous material, and to some extent for tower steel.

Preliminary location work started during January, 1923; procuring of right-of-way options, in March; surveys, in April; the placing of foundations, in August, and the stringing of cable in November. The job was completed by April 1, 1924. At the peak of the work, during November, 600 men were employed for a short time. Kelsey, Brewer & Co., Grand Rapids, Mich., are constructing engineers; L. B. Andrus, vice-president and chief engineer; F. G. Dana, general superintendent.

Pipes Form Footing Reinforcing

WHAT ONE of *Engineering News-Record's* correspondents terms a practical contractor uses the method herein pictured in the construction of certain warehouse concrete footings. The reinforcing is composed of pipes from ½ in. in diameter up, and of pipe fittings of various kinds.

Turntable Replaced in Less Than Two Hours on Southern Pacific Ry.

REPLACING an old 35-ton 70-ft. deck-girder turntable by a 90-ton 100-ft. through-truss turntable in 1 hour 46 minutes was accomplished by the Southern Pacific Ry. at Roseburg, Ore., on April 15. The work in progress is shown in the illustration.

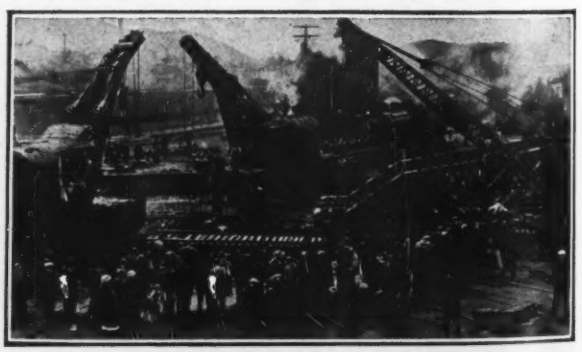
Preliminary work consisted in excavating the pit to its new 100-ft. diameter, cribbing the tracks to permit continuous use of the old table, and building on cedar piles the new concrete circle wall in segments with V-shaped expansion joints. One segment of the wall was left open to permit the sliding into place of the new turntable, which was built on a carriage alongside of the pit. Then the foundation pier of the old table was enlarged and steel plates were set near the corners. A new center cap of reinforced concrete, used to give sufficient bearing in view of the increased load, was built alongside the pit. In addition there were built two portable timber trestles about 25 ft. long, to which were attached chains and cables to facilitate quick handling. These also were erected next to the pit.

The new 100-ft. turntable had been erected on a four-axle carriage, which was placed on a skidway consisting of four well greased rails on cribbing extending to the edge of the 70-ft. pit. Material was at hand to extend this cribbing to the center as soon as the old table was removed. After the last engine had been turned on the old table, a locomotive crane was placed alongside of the new table on the skids. The old table was then turned in line with the new table. Opposite each other and at right angles to the old table were two derrick cars at the edge of the pit.

With this setting actual replacement work commenced. The two derrick cars picked up the 25-ft. temporary trestles and placed them in the pit, where they were immediately rail-bolted, so that the derricks could be moved forward to reach over the center of the turntable. During this time the old anchor bolts were cut with acetylene torches. One crane picked up the old table and swung it clear. The other crane picked up the old center, which had been previously drilled and chained so as to lift easily. While the old table and center were being removed, crews in the pit cleaned out the debris and water, and cut down with jackhammer drills any uneven spots on the surface of the center pier. Then one of the cranes swung the new precast cap into the pit, where it was set on a crib.

To insure setting the cap accurately, eyebolts and leveling screws had been placed in each corner. The crane took a new hold in these eyebolts, lifted the block to permit removal of the crib and then lowered it so as to rest on the leveling screws which had their bearing on the four steel plates set in the foundation pier. A ¾-in. space between the base and the cap was then packed with grout, which was prepared wet but was not in a liquid state. This grout was poured and by means of pumps was forced under the cap through the holes provided for that purpose. The leveling screws were gradually backed off to insure uniform settlement after the grout had been placed. The cap was held laterally by two dowels and wedges at each corner, and was then set to exact grade and center.

While the cap was being set, part of the crew extended the skidway for the new table to the center of the pit and removed the old radial tracks which would have fouled the bottom of the turntable. A cable passing through a snatch block was attached to the new table and extended across the pit to a locomotive in line with the skids. This engine slowly pulled the table



RENEWING A TURNTABLE; SOUTHERN PACIFIC RY. At right; end of new truss turntable being hauled by cable of skidway; locomotive crane used to remove machinery of old table. At left; two wrecking cranes standing on temporary trestles in pit and ready to lift turntable off its carriage and lower it onto the pedestal.

From Job and Office

Hints that Cut Cost and Time

From Job and Office

For Contractor and Engineer

SCHEDULE OF TURNTABLE RENEWAL

	A.M.
Last engine off old turntable	10:06
Temporary trestle picked up by derrick car	10:06
Old turning mechanism picked up by locomotive crane	10:09½
Temporary trestle set	10:10
Derrick hooked onto old table	10:13
Table moved back and in the clear	10:16½
Derrick removed old center	10:17
Old center in the clear	10:19
Cleaning up old foundation and placing grout	10:27
Old circle rail removed	10:24½
New center block lifted	10:22
Block on final location	10:40
Grout poured	11:01
Skidway for new table started	10:25½
Skidway for new table completed	11:07
Locomotive hooked onto cable	11:04
First pull	11:09
Table over center	11:15½
Crane hooked to raise table	11:20
New table lifted	11:21½
Carriage taken from under turntable	11:24½
Skidway taken from under turntable	11:25½
Table let down	11:37
Table set	11:39½
Started to clear up pit	11:42
Pit clear	11:47
Power on	11:50
Motor frame connected	11:50
First turn with table empty	11:51
First engine on table	11:52

along the greased skidway until the carriage on which it rested was directly over the cap. The two derrick cars, again standing on their trestles and at right angles to the table, were hooked to slings attached to the center of the table, lifted it so that the carriage and the skidway could be removed and then lowered the turntable over the center. While the cranes backed off and removed the temporary trestles on which they had operated, framework for the motor and wiring were connected. The table was immediately turned electrically and without load in exactly 1 hr. 45 min. after the last turning of the old table. One minute later a locomotive was turned.

This replacement was in charge of H. A. Hampton, division engineer, and O. V. Chesney, supervisor of bridges and buildings. The engineering details were arranged by F. L. Monroe, assistant engineer. The operating details were handled by D. S. Weir, assistant superintendent; foremen M. G. Kirkpatrick, H. C. Klinge and L. Hitchcock superintended the three bridge and building crews, aggregating 47 men. A schedule of operations is given in the accompanying table. The work was planned and carried out under the direction of W. H. Kirkbride, engineer of maintenance-of-way.

Aid to Slide Rule Calculations

By Clifford N. Miller
Consulting Engineer, Cincinnati, Ohio

THE following rules for determining the position of the decimal point in slide-rule calculations have been worked out by the writer:

The divisions of the Mannheim slide rule are proportional to the mantissas of the common logarithms of the numbers noted. Let the common logarithm of any number be represented by $w + f$, in which w represents the characteristic, a positive or negative whole number, and f the mantissa, a positive decimal fraction. Note that f increases with the significant figures of the corresponding number regardless of the decimal point.

Take logarithms of the equation,

$$x = \frac{ac}{b} \qquad (1)$$

whence,

$$w_x + f_x = w_a + f_a + w_c + f_c - (w_b + f_b) \text{ or,}$$

$$w_x = w_a + w_c - w_b + (f - f_b) - (f_x - f_c) \qquad (2)$$

From equation (2) it is evident that the value of the expression $(f_a - f_b) - (f_x - f_c)$ is zero or a whole number. It is further evident that:

if $f_a > f_b$ and $f_x > f_c$ the value is zero,
if $f_a < f_b$ and $f_x < f_c$ the value is also zero,
if $f_a > f_b$ and $f_x < f_c$ the value is plus one,
if $f_a < f_b$ and $f_x > f_c$ the value is minus one.

Call the fixed scale of the slide rule A and the movable scale B. Equation (1) is solved by setting b on B opposite a on A and reading x on A opposite c on B.

Touring Car for Railway Inspection

ON A RECENT trip to Australia, Trevor C. Nielson, claim agent for the East St. Louis & Suburban Railway Co., made an inspection of Queensland lines in the car pictured above. He was a guest of Mr. Davidson, Commissioner of Railways for Queensland. The car is a converted Studebaker Six, which is used for inspection purposes. The chauffuer must be a qualified engineer, as the inspection car runs on train orders.

From the above may be derived the following rules for determining the value of the characteristic of log x:

1. If the number on A opposite the number on B is greater in both setting and reading or less in both setting and reading, the characteristic of log x is equal to that of log a plus that of log c minus that of log b.

2. If the number on A opposite the number on B is greater in setting and less in reading, the characteristic of log x is equal to that of log a plus that of log c minus that of log b plus one.

3. If the number on A opposite the number on B is less in setting and greater in reading, the characteristic of log x is equal to that of log a plus that of log c minus that of log b minus one.

The value of the characteristic of log x fixes the position of the decimal point.

In solving an equation in which x is equal to a fraction having more factors in either or both of the terms than in equation (1), one performs a series of compound operations, each consisting of a setting and a reading. From all these compound operations the characteristic of log x is equal to the algebraic sum of the characteristics of the logarithms of the factors in the numerator minus the algebraic sum of the characteristics of the logarithms of the factors in the denominator plus the algebraic sum of the plus ones and the minus ones.

Bridge Alterations at Clifton Forge, Chesapeake & Ohio Ry.

BRIDGE REMOVAL and bridge alterations necessitated by the enlargement of freight yards at Clifton Forge, Va., on the Chesapeake & Ohio Ry., included: (1) Removal of a two-span truss bridge carrying the main tracks; (2) the removal of an intervening highway truss bridge; (3) the construction of a wide plate-girder bridge for the yard tracks, and (4) two shifts of the main tracks crossing the Jackson River.

With the extension of the yard, its east end will come at about the point where the main tracks were carried over the river by a double track through-truss bridge having two 125-ft. spans. To provide for the yard throat this bridge will be moved 150 ft. to the north, making room for a plate-girder structure with four 65-ft. spans and having an average of 37 lines of girders spaced 7 ft. c. to c. On these girders will be

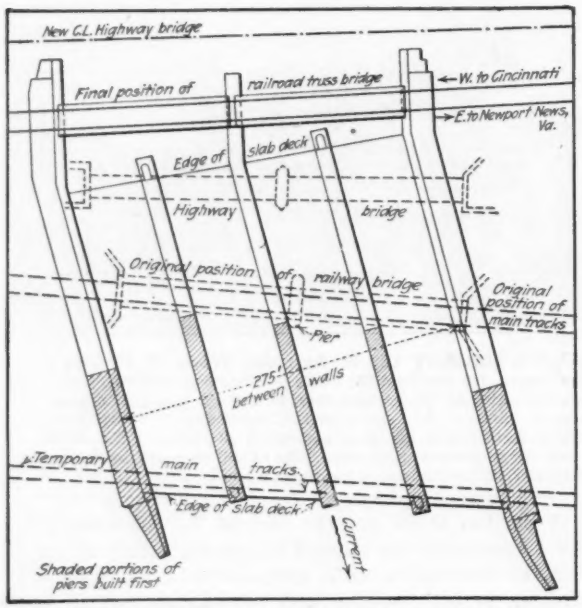


FIG. 1—BRIDGE WORK AT CLIFTON FORGE, VA.

a concrete-slab deck, about 230 ft. wide at one end and 290 ft. at the other, for the ballasted tracks of the yard. This deck arrangement provides for shifting the yard tracks as may be required. The general situation is shown in Fig. 1, with details of the plate-girder bridge for yard tracks in Figs. 2 and 3.

The new piers for the girder bridge were first built with a length of about 130 ft. on the south side of the truss bridge and then this latter bridge was utilized for placing the girders. Across the bottom chords of each south truss were placed 12 x 12-in. timbers, 8 ft. long, anchored at the inner end and having a cantilever projection of about 2 ft. outside the truss to carry two lines of 9 x 16-in. timbers laid flat, one on top of the other. On the top timber were spiked two lines of 100-lb. rails.

To handle the 65-ft. 25-ton girders, they were brought on cars to the west end of the bridge, where a locomotive crane unloaded each girder and placed it on timbers in line with those laid outside the trusses. A cable from a hoisting engine on the east side then pulled the

From Job and Office

Hints that Cut Cost and Time

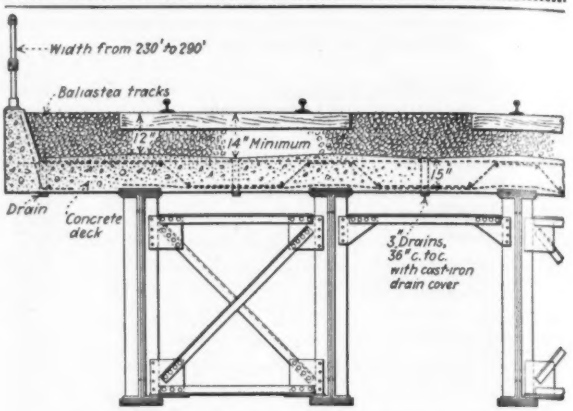


FIG. 2—GIRDER BRIDGE FOR YARD TRACKS

girder into its longitudinal position over the piers. To hold the girder upright and prevent its tipping over, guides were attached to the truss posts, each guide consisting of a horizontal bar placed just above the height of the girder and having its outer end bent downward to engage the girder flange.

Across the top of each truss span was laid a 12 x 12-in. timber, projecting beyond the south truss so as to carry a hoisting tackle operated from the hoisting engine. One end of the girder was attached to this tackle and the other end to the tackle of a railroad derrick car stationed on the bridge with its boom projecting through the space between the inclined end posts of the two spans. The girder was then lifted clear of the sliding rails and landed on skid rails laid along the piers and abutments. By means of snatch blocks at the ends of the piers, the hoisting engine then pulled the girders laterally to their positions on the piers, the girders being held vertical while moving by bracing them together in pairs. As soon as the first eight lines of girders were placed, the concrete deck slab was poured and a temporary double-track line laid.

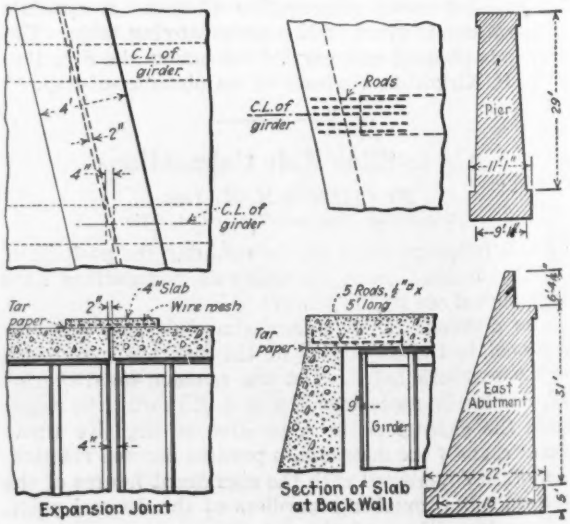


FIG. 3—PIERS AND DETAILS OF GIRDER BRIDGE

From Job and Office

For Contractor and Engineer

With the truss spans thus cut out of service they will be jacked up 4 ft. to the new grade and then hauled laterally along the piers by cables and hoisting engines to their new position beyond the north side of the new girder bridge. Cars on the south end of the completed part of the latter bridge will then bring out additional girders which will be placed by derrick cars on the piers until the full width is completed. Top and bottom laterals connect the girders and sway bracing connects alternate lines of girders, as shown in Fig. 2. The reinforced-concrete deck will have its top surface formed in drainage planes, with 3-in. drain pipes spaced approximately 3 ft. apart in the valleys, but so placed as not to drip on the steelwork. This slab will be from 15 to 17 in. deep, and will have an 18-in. curb wall on each side to retain the stone ballast, about 12 to 14 in. deep below base of rail. It has been proposed also to carry a highway along the south side of the bridge, since a highway bridge north of the present railway truss bridge (see Fig. 1) will have to be removed or destroyed.

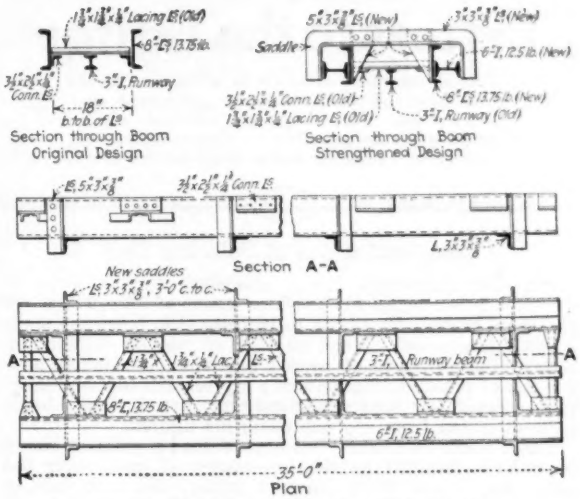
The steel erection was done by company forces, which will also handle the shifting of the truss spans to their new position. All this work is planned and executed under the direction of C. W. Johns, chief engineer, Chesapeake & Ohio Ry., and C. Miller, bridge engineer, with E. G. Rice, district engineer, in charge of construction.

Failure and Re-design of Boom

By S. E. Berkenblit
Structural Engineer, Chicago, Ill.

An example of structural failure in bending and twisting simultaneously, is a boom which failed during heavy excavation on roadwork in Illinois. The excavator was of the tower type, with a projecting horizontal boom having on the underside a runway for a trolley carrying a grab bucket; guys from the head of the tower were attached to the end of the boom. This boom, shown in the accompanying drawing, consisted originally of two 8-in. channels 18 in. back to back, connected with one line of 1¾x1¾x¼-in. lacing angles riveted to the center of the webs. A continuous 3-in. I-beam was secured to the top of this lacing, midway between the channels, to serve as a trolley beam. The entire frame was evidently made by a machine designer, whose principal aim was to secure an appliance for mechanical handling of materials and who gave little consideration to the strength of the frame as a whole.

It will be seen that the angle lacing had the double purpose of bracing the channels and carrying the trolley beam. The location of the lacing angles at the center of gravity of the channels is such that little stability is offered to the twisting of the latter, while the lack of bracing at the flanges gives every opportunity for excessive sidewise deflection under bending stresses. Both of these failures occurred. It appears that the failure of the boom was gradual and started with the bending of the top flanges inward and was



STRENGTHENED BOOM FOR EXCAVATOR

followed by gradual twisting of the channels unevenly, so that the I-beam was pulled off its original position with its web no longer vertical and so could not be used as a runway. In the belief that all a deformed object needs for "getting back into shape" is a little hammering, the contractor's men were hurriedly trying to heat the frame to a cherry red in spots, and figured they could restore it to its original shape in a few hours.

In the boom as rebuilt, and shown in the drawing, two new 8-in. channels were substituted while the lacing angles and runway beam were left intact, so that no additional work was necessary in readjusting the mechanical end of the frame. It was thought advisable to design the principal body with some excess of strength over the subsidiary framing, consisting of the lacing angles and runway beam. With this in view, the channels were strengthened horizontally by 6-in. I-beams, thus considerably increasing the strength of each part as a strut. No bracing could be placed at the top, owing to the trolley requirements, but 3x3x⅜-in. angle saddles were introduced about 3 ft. c. to c. and connected to the channels by 5x3x⅜-in. angles as shown. This arrangement formed a rigid three-sided frame to counteract sidewise deflection or twisting. The saddles were further bent around and fastened to the horizontal I-beams.

The strength of the frame was governed principally by the riveted connections of the subsidiary parts, and a load of 10 tons was considered as a practical limit under the circumstances. When thus rebuilt, the frame was very stiff and kept the runway beam in perfect alignment.

Job and Office Notes

Four Power Plants Using 8-cylinder Cadillac motors are in service in the Sacramento Canyon, Calif., driving rock crushers for the production of road surfacing material for the California State Highway Commission. The engines, which were acquired by the U. S. Government for war purposes, have been rebuilt in the Sacramento shops of the highway commission, thereby making possible the practical adaptation of surplus war material to highway construction uses.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Costs and Rates of Painting Steel

Sir—Mr. Schworm's letter, published in your issue of June 26, referring to his previous paper of May 1 and my comment of May 22, seems to indicate that I did not make myself understood. I had no idea of making a generally unfavorable criticism of what I said was "a valuable article full of detailed information"; my remark that the labor cost seemed low was complimentary, but I think should have attention from any one using his figures.

I still think that he did not buy as good a paint as would have been justified by the importance of the work; the paint which cost $2.80 (carload prices) for materials in 1923 was 30 cents lower in part of 1921, but still much above what he paid. It is true that buckle-plate and plate girders are easy painting, but it is very unusual to get 1.5 gal. per day well brushed on. A master painters' association estimates 0.62½ gal. as an average day's work in house painting, and my own rather long experience indicates 1 gal. as a fair day's work in bridge painting; I have been reliably informed of 2 gal. a day as having been done in shop-painting, using a thin graphite paint and 6-in. flat brushes, but I am not willing to admit that it is good practice. It is possible, no doubt, to put on 1 gal. of good paint in 4 hours and do it well, but it is not to be regarded as commercial work.

As to the estimates I quoted, I gave them to show what a really competent contractor can do who works along a narrow line and hires his men by the month or by the year. To him the rest of us are amateurs. In time all of his men become experts. I wish I could have seen the work done; it was reported as excellent by the public inspector. What wages were paid I do not know, but probably much below current day-wages.

If other public engineers, and the railway bridge men, would give us more such details as Mr. Schworm has furnished it would be for the good of all concerned.

A. H. SABIN,
Consulting Chemist, National Lead Co.

New York, July 1, 1924.

Railway Location and Economics

Sir—Your description of the long-talked-of loop of the Union Pacific into Boise, published June 12, p. 1014, taken with other projects and rulings of the Interstate Commerce Commission, add, it seems, to the confusion of new economic theories of railroad location. I had about concluded that a policy was being established to prohibit hauling freight over a mountain when it can be avoided on a parallel line.

But here we see a road paralleling its own excellent line using 33 per cent more distance, 240 per cent more curvature and heavier grades with no commensurate benefits mentioned except convenience for Boise passengers. The mountain is only 177 ft. high but it will cost a pretty bill in operation. We will all be delayed half an hour when traveling that way by the sharp curvature and long maximum grade. It can never be used for double track without robbing Boise of half the benefits, the only apparent object of the line or loop. I presume the Interstate Commerce Commission approved the improvement, if such it is.

This is of interest to Colorado and other places where the same questions are up for solution, though on a much larger scale.

Here, 335 miles are involved; the mountain is 1,000 ft. high for traffic from the southeast and 3,600 ft. high for traffic from the northeast. The Missouri Pacific and Union Pacific come from the southeast and the Burlington and Union Pacific from the northeast. Northern Colorado has bonded itself $6,000,000 for the Moffat tunnel six miles long now under construction; but the present opposition of the Interstate Commerce Commission may prevent its being used for any but local traffic. They are favoring the old pioneer Gould lines, without any consideration of operating costs, apparently. I am very sure they have never seen a comparative profile of the two lines they are now selecting between Eads and Glenwood Springs. They can probably put the new line to sleep for a generation. They may thus delay all passenger trains an hour and freight trains three hours in passing through this state.

The hours are frequently changed to days during times of floods on the Arkansas and snow in the mountains. Crops rot nearly every year in western Colorado for lack of railroad facilities, cars and reasonable rates. After this improvement it will be on account of the Interstate Commerce Commission ruling, in their laudable efforts to protect old investments.

I submit that first consideration should be operating expense—that that road which can render the most efficient service should be allowed to do so. The commission should be conservative.

Large savings should first be proven. If they would pay some attention to performance of trains under the different conditions and to trackwork such proofs would soon be available.

It is humiliating to be still obliged to use Wellington's units of train resistance a half century old, but they can't be ignored.

They are criticised but they are the only authority we have, and they are the only recourse for the engineer when he is finally cornered with such questions. I have seen Wellington's compensation for curvature in grades used for automobiles—a thing which he never heard of. If the Interstate Commerce Commission would tabulate and investigate experiments that are made in that line we would soon have something to use in modern practice, and with certainty.

Traffic does not follow lines of least resistance.

For thirty years the Missouri Pacific has hauled freight into Denver over a hill 1,700 ft. high and with 26 miles extra distance because they could not be made to transfer cars to the Union Pacific at Kit Carson.

If they could be made to do that reasonably, so as not to obstruct the free flow of traffic, I don't see that it should matter how they combine and organize. Now I am not getting away from the subject. It is all an engineering subject being mismanaged by the Interstate Commerce Commission lawyers and politicians in the old-fashioned way.

Denver, Colo. A. M. HAYNES,
June 22, 1924. Denver. Colo.

City-County Manager Defeated at Butte

Consolidation of the city and county of Butte, Mont., under a city-county commission-manager plan of government, as authorized by a constitutional amendment adopted in November, 1922, was defeated at an election in May of this year. There was strong opposition to the plan by the politicians and office holders. Of a total registered vote of 20,300, there were 14,374 votes cast, or 70 per cent of the registration. The vote stood 6,857 for to 7,517 against consolidation. Allegations have been made that a large number of illegal votes were cast and there has been talk of contesting the election. Under the legislative act passed in accordance with the constitutional amendment, there would have been, had the act been adopted, a council of seven members and a city-county manager. In general, the act followed the well-known commission-manager type of city charter. Heads of departments would have been appointed by the manager; and subordinates, also, unless the manager authorized the department heads to make the appointments. Under either of these alternatives appointments would have been "on the basis of the ability, training and experience of the appointees in the work which they are to perform." The act provided that the director of public works should have the "qualifications prescribed by law for county surveyors."

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Los Angeles Farms Out Engineering Works

Contracts with Local Engineers for Making Plans, Profiles and Estimates for Street Improvements

Petitions filed by property owners for public improvements in Los Angeles, calling for the paving of about 250 miles of streets, have accumulated to such an extent that the city engineer's staff is reported to be entirely inadequate to cope with the situation, and many petitions have been on file awaiting attention for more than two years. To relieve the congestion in the engineer's office, the city council on May 27 appropriated $50,000 and authorized the Board of Public Works to employ additional engineers to assist in the preparation of the ordinances that must be adopted before contracts can be awarded and work started.

After much discussion in which the legal as well as the engineering phases of this expansion were considered it was decided to take proposals from engineers in private practice and assign the engineering work by items on the basis of competitive bids. The work of the private engineers ends with the writing of the ordinances ordering the improvements, the city supervising all construction.

Substance of Ordinance

The ordinance authorizing the action outlined above was prefaced by various whereases citing such things as "the remarkable and unprecedented growth" of the city, the inconvenience and annoyance to citizens and property owners who have petitioned for public improvements that have not been acted upon, the "lack of space and lack of experienced men" in the city engineer's office, and the "vital importance" of the matter "to the proper handling of traffic congestion and the natural expansion of the city" incident to these delays. The actual wording of the ordinance authorized employment of twenty civil engineers for a period of six months to meet the situation and provided that the engineers should "receive such compensation in each proceeding as shall be fixed by contract authorized by the Board of Public Works" of the city. What appears to have been a resolution supplementary to the ordinance authorized the Board of Public Works "to enter into a contract . . . for the leasing of office space and the incidental use of drafting tables, materials and supplies, and technical assistance necessary to perform properly the work of preparing the preliminary plans, profiles, assessments, district maps and ordinances in connection with the petitions requesting the improvement of streets and other public works now in the hands of the Board of Public Works." The responsible authorities seem to have interpreted the ordinance and resolution as an authorization for inviting proposals for the work in question.

Some of the engineers at Los Angeles have regarded this whole proceedings as unethical. It is reported that the bids received have varied by 400 per cent and that the highest bid was submitted by the only member of the American Society of Civil Engineers who has competed for the work.

In further explanation of the situation that has led to this procedure at Los Angeles, it is stated that the City Hall is not only overcrowded but that the engineering department has already overflowed into other buildings. It is also stated that there were a number of former city employees in private practice who had had experience in doing this particular kind of work, but to engage them privately would lay the authorities open to criticism of favoritism.

John H. Dunlap, Injured in Wreck, Slightly Improved

Word received July 9 from Chicago is to the effect that John H. Dunlap, secretary of the American Society of Civil Engineers, who was injured June 30 in a train wreck near Buda, Ill., is slowly improving. His seventh vertebra was fractured, resulting in complete paralysis for a short time. He has regained the use of his arms and hands, to some extent, but his lower limbs are still paralyzed. His temperature is reported as normal, he is able to eat certain food and his general condition is satisfactory.

F. W. Ives, newly-elected president of the American Society of Agricultural Engineers, whose back was broken, died last week.

S. P. Plans Arizona Line

In line with its proposed acquisition of the El Paso & Southwestern R.R. and the improvement of its properties in Arizona as announced in *Engineering News-Record* June 19, 1924, p. 1075, the Southern Pacific Ry. has applied to the Interstate Commerce Commission for authority to construct the following extensions and branch lines in the State of Arizona: A new main line from Picacho to a connection with the Chandler branch near Chandler, a distance of 50.5 miles; a branch line from Gila River to Florence, a distance of 7 miles; and a new main line extending from Hassayampa to Dome, a distance of 115 miles.

$10,000,000 Drive On For Engineering Museum

$1,000,000 Already Assured—Dr. Elihu Thompson Heads New National Scientific Organization

One million dollars has been assured towards the establishment of the National Museum of Engineering and Industry, Inc., with headquarters in the Engineering Societies Building, New York City. A campaign to raise an additional $9,000,000 started July 5. The president of the new organization is Dr. Elihu Thompson, who on July 5 received the Kelvin gold medal from the Royal Society at the Kelvin centenary in London. The vice-presidents are Dr. Edward G. Acheson, one of the creators of the modern abrasive industry Dr. Leo H. Baekeland, president of the American Chemical Society, and Dr. Edward Weston, creator of the Weston type of electrical instruments. Its trustees are Philip T. Dodge, chairman of the International Paper Co., Howard Elliott, chairman of the Northern Pacific R.R., Dr. Ira N. Hollis, president of the Worcester Polytechnic Institute, Dr. Elmer A. Sperry, president of the Sperry Gyroscope Co., and Worcester R. Warner, of Warner & Swasey, Cleveland, Ohio. George E. Roberts, vice-president of the National City Bank, is treasurer, and H. F. J. Porter is secretary.

In co-operation with the Smithsonian Institution the new organization is planning to erect on its grounds in Washington a building to house the original models of early inventions and the records of constructive achievement of pioneers, inventors, and engineers.

In addition to the central collection at Washington special collections such as replicas of the historical exhibits will be carried to the people, also live machinery of modern processes will be placed in affiliated museums in industrial centers of every state.

Incorporation was effected in March last under the laws of the District of Columbia by the "Organizing Committee of 100" composed of chairmen of boards of directors, presidents and chief engineers of industries and railroads, and professors of engineering and history in universities and colleges.

Union Pacific Plans Extensions

According to Carl R. Gray, President of the Union Pacific, that railroad will spend $29,500,000 for extensions, new equipment and new shops. The plans include the construction of the 44 miles of second main line through Boise, Idaho, from Orchard to Nampa; a 98-mile line from Rogerson, Idaho, to Wells, Nevada; and a 30-mile line from Crane to Burns, Oregon; and a 17-mile extension northerly from Fort Collins, Colo. New equipment includes 35 new locomotives and 500 steel tank cars.

Research Is Main Topic of Engineering Educators

S. P. E. E., Meeting at Boulder, Hears Wickenden Report—Entertainment Features Attractive

BY ANSON MARSTON
Dean of Engineering, Iowa State College

The Society for the Promotion of Engineering Education held its 32nd annual meeting at the University of Colorado, Boulder, Colo., June 25-28, inclusive. The attendance, 362, exceeded all former records. The 150 members present represented 70 colleges, 38 states, Canada and Hawaii. Doubtless the large registration was in part due to the attractiveness of Colorado for summer vacation programs.

The entertainment features of the meeting were very complete (even the small children were remembered), and besides the usual banquet and reception included a mountain canyon drive, with a rainbow trout fry supper, inspection of an 1,800-ft. head hydro-electric power plant and an (ultimate) $12,000,000 steam power plant.

Perhaps the dominating characteristic of the sessions was the comparative absence of lengthy expressions of personal opinion and the substitution therefor of the presentation of educational research data and ideas. The discussions in the main were arguments over the proper conclusions. Nevertheless, the old-time debates and speeches were not entirely missing, especially when our veteran friend Engineering English made his usual prominent appearance on the program.

A new plan of stimulating the activities and interests of the groups of members of the society engaged in specific branches of engineering was tried Wednesday, when a preliminary meeting of those interested in mining engineering was held at the Colorado School of Mines at Golden, with 40 present. The consideration of mining engineering education was continued Thursday morning in the first session at Boulder, when a paper prepared by Dean G. M. Butler of Arizona on "The Development of Mining Engineering Education Since 1910" was presented.

Longer Courses—Dean G. B. Pegram of Columbia explained the present situation of the six-year engineering courses at his institution, which is, that, although the work is very satisfactory, an almost negligible number of students are graduating.

In the afternoon of Thursday Professor W. H. Burgess of Northwestern University read a paper by himself and Director J. F. Hayford entitled "Fifteen Years of Experience with a Five-Year Engineering Curriculum." Northwestern likes the plan, and the attendance, though small, has averaged 9 per cent annual increase. But only 13 per cent of the students who enter complete the fourth year and 8 per cent the fifth year, as compared with 35 per cent to 40 per cent in the average four-year engineering courses.

In the discussion Iowa State College reported that more than 25 per cent of her engineering graduates have had college work preliminary to entering an engineering course, to such an extent that they have completed five to eight years' total college work upon graduation.

Many engineering educators believe that five- or six-year engineering courses are needed for the adequate training of present-day engineers, but most of them also believe that such courses cannot be made successful without concerted action by all the best engineering colleges and by the engineering profession as a whole. Director Wickenden, of the Board of Investigation and Co-ordination, strongly supported this view the next day, and on Saturday he urged that preparation for concerted action by the engineering colleges on this and other matters be made by an effective organization of the institutional delegates.

Mr. Wickenden is chairman of the board which is administering the $108,000 fund created by the Carnegie Foundation for the study of engineering education to be carried out under the direction of the society. The grant was made in late October of last year, Mr. Wickenden was appointed director in November and the Board of Investigation and Co-ordination was set up by the society in March of this year. The board contains ten members representing all branches of the profession.

Wickenden Investigation — In his presentation on Friday of the plans and the progress of the national plan of engineering education investigation and research Mr. Wickenden gave statistics showing that in the past the medical and the law schools of the United States have been subjected to grave abuses of proprietary exploitation for private profit at the expense of educational standards, abuses from which the engineering colleges always practically have been free. Even now much less than half the law students in the country take as much college work as is required in every standard engineering course. Only by active concerted action of all the best medical schools and the entire medical profession have the medical schools established their present standard of six years' college work, followed by at least one year of experience in a hospital under supervision.

While the present high medical standard is especially desirable because the young physician cannot usually serve a professional apprenticeship under older members of the profession corresponding to the usual practice in engineering, yet the increased severity of medical education requirements has caused a reduction of the annual number of medical graduates in the United States from 4,741 in 1908 to 3,120 in 1923, with greatly increased cost to the public of medical service.

The present attitude of engineering educators on the proper length of engineering curricula seems to be one of watchful waiting. The belief is growing that mere juggling with the details of the present four-year courses can effect only minor improvements and that any great advance in engineering education will require longer curricula.

Progress in Investigation — Very comprehensive plans for the great research upon which the engineering colleges are entering were reported. Thirty-four colleges already have been visited and the field reconnaissance will be extended to 40 more this year. A large number of colleges are co-operating by undertaking extensive collection of research data covering every phase of engineering education. Professor H. P. Hammond, of Brooklyn Polytechnic Institute, has been engaged as assistant director to devote full time for the next 15 months to this phase of the work. Director Wickenden plans to spend the first half of 1925 investigating engineering education in Europe. The U. S. Bureau of Education is collecting historical and other research data of engineering education as a part of the general program.

The co-operation has been secured of the great industrial organizations (through the Joint Industrial Conference Board) and of the great national engineering societies (through a joint council). These agencies will assist in making job analyses of the work of engineers in different occupations and of the numbers of engineering graduates required to meet the needs of the country.

In a word, we now have, on paper at least, an organization comprehensive enough, first, to conduct a comprehensive research to ascertain the true fundamental data of engineering education, and, second, by concerted action to put into effect whatever improvements may be found advisable.

In the program of research the technique of teaching is not being overlooked. On Friday Dean C. E. Seashore presented the same interesting views which he recently has carried direct to so many faculties, on methods of teaching which will enable each student to achieve his individual utmost regardless of the class average.

Officers — The new officers of the society are: President, Dean A. A. Potter of Purdue; vice-presidents, Prof. R. S. King, Georgia Institute of Technology, and Dean G. B. Pegram, Columbia University. Members of the council for three years, Dean G. M. Butler, University of Arizona; Prof. H. Pender, University of Pensylvania; Dean E. B. Norris, State College of Montana; Prof. W. E. Brooke, University of Minnesota; Assistant Dean H. H. Jordan, University of Illinois; Prof. W. H. Kenerson, Brown University, and Director W. E. Wickenden. The secretary, Dean F. L. Bishop of Pittsburgh, and the treasurer, W. O. Wiley, of New York, were re-elected.

A new constitution was considered and referred back to a committee for further study. The present constitution was amended to do away with the publication of a special bound volume of "Proceedings." The separate numbers of "Engineering Education," published monthly (10 issues per year) by the society will constitute the proceedings.

The 1925 meeting will be at Union College, Schenectady, New York.

The new "Division of Deans and Administrative Officers" decided against a mid-year meeting, but will hold sessions Tuesday and Wednesday preceding the annual meeting of the society. Dean H. S. Boardman, of the University of Maine, was elected chairman of this division for the ensuing year.

A. E. C. Urges Coal Storage in Lengthy Report

Engineers Submit Plans for Avoidance of Shortage—Costs Given—Methods Outlined

Elimination of danger of coal famine, stabilization of the industry, relief to railroads and an ultimate cut in the consumer's coal bill are possibilities by the seasonal storage of coal, in the opinion of the Storage of Coal Committee of the American Engineering Council. The report was made public July 7.

The report emphasizes the fact that one of the principal reasons why shortages exist is seasonal demand with no provision for seasonal storage which has resulted in opening twice as many mines as are needed. This condition could be corrected if consumers adopted a policy of annually purchasing coal on a uniform monthly delivery basis, resulting in a uniform demand whereby coal producer and carrier may establish uniform and standard production and shipment schedules.

"Since more coal is consumed in the late fall and in the winter than at other periods," the report reads, "coal producers and carriers each year are confronted alternately with a feast and a famine—with an inordinate demand for coal and transportation followed by a period of no demand. This seasonal demand is responsible for 47 per cent of the idle time of the coal industry."

Storage Costs

The report sets forth a simple and practical remedy for coal storage. It asserts that equipment has been developed and may be secured to meet any storage situation or requirement. The cost of such equipment ranges from a few cents per ton of capacity up to $2.50 or $3 per ton of capacity. The report points out that the storage of coal presents no serious risk of loss from breakage, spontaneous combustion, or loss of heat value or firing qualities. However, the cost of storage, the report indicates, including fixed charges on equipment, maintenance and operation expense and interest on investment in coal as well as taxes and insurance, in most instances does not exceed 75c. per ton yearly. More generally it is about 50c. per ton yearly.

The amount of storage necessary to produce corrective results the committee finds is only from 9 to 10 per cent of the annual consumption. If this amount is supplemented by additional reserve storage of no more than 7 per cent, an accumulation of about 83,000,000 tons of coal in storage by Sept. 30 of each year will result. In general, storage at the mines is not recommended. Also, storage in transit or at intermediate points is not usually advised. The report emphasizes the need for storage at the point of use to accomplish the most in relieving transportation and safeguarding supply.

The report, which was issued by ex-Governor James Hartness, of Vermont, president of American Engineering Council comprises about 110,000 words. It was prepared by a committee of the council headed by W. L. Abbott, of Chicago, working with the Department of Commerce, the U. S. Coal Commission, and federal, state, and municipal agencies as well as private enterprises. Sixty-seven sub-committees functioning in every important industrial center in the United States and comprising 400 individual engineers constituted the field organization which carried on the survey for more than a year.

John C. Trautwine Dies

John C. Trautwine, Jr., son of the originator of the Trautwine handbook for civil engineers and himself its editor since 1883, died at his home in Philadelphia July 4.

Mr. Trautwine was born in Philadelphia March 17, 1850. He received his early education in private schools in that city, becoming associated with his father at an early age. He entered consulting civil engineering practice at the age of 33 in Philadelphia, at the same time taking over the editorship of the civil engineers' handbook.

Mr. Trautwine was a contributor to the technical press. With Rudolph Hering he translated Ganguillet and Kutter's "Flow of Water in Rivers and Other Channels." With A. Marichal he translated Bazin's "Flow Through Orifices." From 1895 to 1899 he served as chief of Philadelphia's Bureau of Water.

He was a member of a number of technical and scientific societies among them being the American Water Works Association, American Society of Civil Engineers (associate), American Society of Mechanical Engineers and the Institution of Civil Engineers.

New York's New Subway Board Appointed by Mayor

The personnel of the new Board of Transportation for New York City which, on July 1, took over all planning and construction of new subways, has been completed by the appointment of William A. De Ford, a lawyer, as the third member. The other two members are the chairman John H. Delaney, until recently commissioner of docks, and formerly transit construction commissioner before the creation of the present Transit Commission, and Daniel L. Ryan, deputy commissioner under Mr. Delaney when he was transit construction commissioner. F. J. Sinnott has been appointed secretary of the new board.

Robert Ridgway, formerly chief engineer of the Transit Commission, has been appointed chief engineer of the Board of Transportation. Daniel L. Turner, consulting engineer to the Transit Commission, remains with the commission for the study of transit conditions in the metropolitan area.

Lake Michigan Sanitation Congress Established

Delegates From Four Lake States Discuss Water Supply and Sewage Disposal

Official state and municipal delegates from the four states bordering the lower end of Lake Michigan brought into being on June 27 and 28 the Lake Michigan Sanitation Congress at Hammond, Ind. The use of the shallow waters of the lower end of the lake for sewage disposal and water supply has produced such a menace and nuisance that it is felt early measures must be taken to ameliorate the conditions. The congress was called by the Hammond Chamber of Commerce, instigated, however, by the Lake County Medical Association. The purposes are to arouse interest in the problem, to acquaint the public with the facts, to point out imminent dangers, to suggest remedies and to secure co-operation and proper legislation.

A dozen papers and addresses of a semi-technical character and an inspection trip along the lake front and down the main channel of the Sanitary District of Chicago made up the two-day program.

Many Topics Discussed

W. R. Copeland, chemist, Milwaukee Sewage Commission, spoke on "Milwaukee's Sanitation Program." C. M. Baker, chief engineer, Wisconsin State Board of Health, emphasized the relation of sewage treatment with a water supply, the latter being the first line of defense in his opinion. Dr. W. A. Evans, *Chicago Tribune;* Langdon Pearse, Sanitary District of Chicago; Dr. Isaac D. Rawlings, commissioner, Illinois Board of Health; H. F. Ferguson, chief engineer, and Robert I. Randolph, representing the Chicago Association of Commerce, presented various phases of the problem as it affects Chicago and Illinois. For Indiana, Dr. W. F. King, commissioner of health; L. A. Geupel, director of the water and sewage department, spoke on the sources of pollution and existing conditions. Likewise for Michigan, E. D. Rich, state sanitary engineer, and F. S. Badger, his assistant, indicated the methods of cleaning up conditions at the West Michigan resort cities. Surgeon W. H. Frost, U. S. Public Health Service, indicated how far federal aid had extended on similar problems elsewhere.

A resolution supporting lake diversion by the Sanitary District of Chicago was laid on the table on objection by the Wisconsin delegates, but other resolutions condemned lake pollution by sewage and dumping of dredged materials, called on the cities to eliminate it and proceed with the utmost diligence to establish water filtration plants and sewage treatment works. The recent request of Illinois and Indiana for a joint public health survey with the U. S. Public Health Service of the lake cities from Sixty-eighth Street, Chicago, to Gary, Ind., and the pollution of the lake and the streams in the Calumet region, was indorsed.

Henry W. Lee was elected president of the congress.

A. S. M. E. Nominates Officers

Nominations for officers of the American Society of Mechanical Engineers for 1925 were announced at the spring meeting of the society which was held in Cleveland several weeks ago. Election will be by ballot of the entire membership, closing on Sept. 23, 1924. The nominees, as presented by the regular nominating committee are:

President, William F. Durand, Stanford University, Calif.; vice-presidents, Robert W. Angus, faculty of applied science and engineering, University of Toronto, Canada; S. F. Jeter, Hartford Steam Boiler Inspection Insurance Co., Hartford, Conn.; and Thomas L. Wilkinson, consulting engineer, Davenport, Iowa; managers, John H. Lawrence, Thomas E. Murray, Inc., New York, N. Y.; Edward A. Muller, King Machine Tool Co., Cincinnati, Ohio; and Paul Wright, Paul Wright & Co., Birmingham, Ala.; treasurer, William H. Wiley, John Wiley & Sons, Inc., New York, N. Y.; delegates to the American Engineering Council, W. F. Durand, Stanford University, Calif.; William P. Hunt, Moline Tool Co., Moline, Ill.; I. E. Moultrop, Edison Electric Illuminating Co. of Boston; E. N. Trump, Solvay Process Co., Syracuse, N. Y.; William W. Varney, attorney, Baltimore, Md.; Ira Dye, industrial engineer, Seattle, Wash.; W. S. Finlay, Jr., American Water Works & Electric Co., New York, N. Y., and Dean E. Foster, consulting engineer, Tulsa, Okla.

R. F. Grant Heads U. S. Chamber

Richard F. Grant of Cleveland, vice-president of the M. A. Hanna Co. and a former president of the Cleveland Chamber of Commerce, has been elected president of the Chamber of Commerce of the United States succeeding Julius H. Barnes, of Duluth. Mr. Barnes has served two full terms as president of the U. S. Chamber. At the meeting at Cleveland in June of this year he was asked by the Board of Directors to continue as its head but was unable to accept.

Construction Started on Tunnel for Los Angeles Street Cars

A double track tunnel, 4,225 ft. long is now under construction in Los Angeles which is to provide a new route for Pacific Electric Ry. cars from the business district toward Hollywood thus avoiding the congested streets which now delay through traffic. Contract for the tunnel was awarded to Twohy Bros. and work was begun early in May. The total cost of the project is to be about $3,500,000.

The downtown end of the tunnel is in the railway company's present Hill St. terminal and in going through the hill the tunnel will curve to the north so as to come out at Glendale Boulevard and First St. The tunnel is to take more than 1,000 cars and trains per day from the congested streets of the business district, providing them with a shorter route over which they can operate at a speed of 30 to 35 miles per hour to a connection with the Glendale Boulevard whence comparatively good time can be made to Hollywood, Glendale, and other outlying portions of the city.

The tunnel is to be 28 ft. wide inside the concrete lining and will have approach cuts 300 and 500 ft. long, respectively. It is to be completed in 18 months. Six contractors bid on this job, several of the tenders differing by less than $100,000.

PRINCIPALS IN PACIFIC ELECTRIC EXTENSION

Left to right: E. C. Johnson, chief engineer, Pacific Electric Ry. Co.; Judge John Twohy, Twohy Bros., contractors; D. W. Pontius, vice-president and general manager, Pacific Electric Co.; and W. R. Fontaine, tunnel engineer with Twohy Bros.

Random Lines

More Name Pilfering

The Unitarian Laymen's League is going to have a convention at Niagara Falls and, according to their bulletin "The Spokesman," a number of Clergymen "have been invited to be present as 'consulting engineers' for personal conferences with delegates." How far a good deed doth throw its gleam in a naughty world.

* * *

$$R = N \frac{P_s + \int_a^z V}{W^2}$$

"The style of a man's play, plus the normal range of his vices, divided by the square of his work, and multiplied by the coefficient of his nationality gives not only his potential resistance under breaking strain, but indicates, within a few points, how far he may be trusted to pull off a losing game."
—*From a recent address by Kipling.*

* * *

We Are Put in Our Place

The *Moving Picture World* comes to the defense of its own in the following comment on a letter from a subscriber:

Attached is an alleged humorous clipping from *Engineering News-Record*, a civil engineering magazine which evidently questions the right of those men who gather in convention twice each year as the Society of Motion Picture Engineers to call themselves "engineers."

I am wondering if the American Society of Civil Engineers can point out one of their conventions which was attended by so many real men of science, some of whom have world-wide reputation, as were gathered, for instance, at Ottawa last fall. Apparently that organization fails to recognize the fact that what yesterday was a mere passing fancy is now the fifth largest industry in the entire world, and that the very foundation upon which this giant rests is the artistic blending of light and shadow, "color, music and scents, the highest form of art which we shall know" must be grounded as deeply in scientific knowledge as the project of bridging the Golden Gate.

"All of which brings to our mind the changing meaning of the word Engineer. In days gone an engineer was meant a man who operated or "ran" an engine. Today the meaning includes many things.

"Certainly no e but the fool would dispute the statement that a very high degree of scientific knowledge is required to produce the thing the public of today sees on the screen in the modern motion picture theater. The process is of such delicacy that a single slip throughout any one of the many operations necessary to the finished result upon the theater screen may utterly ruin the whole thing.

"The clipping is not funny notwithstanding the fact that the *Record* editor may have meant it to be. All the various things he has named may call for real engineering skill.

"Wrecking operations call for scientific knowledge of very high grade, and if you don't think life saving requires skill and knowledge, try to get a line aboard a wreck during a howling tempest, with anywhere from one to a thousand lives depending upon the line reaching the vessel. Verily, some men, editors included, have a queerly twisted sense of humor."

Building Permit Issued on Incomplete Plans Voided

A permanent injunction restraining the construction of an apartment building was granted by Judge Marx, of the Superior Court, Cincinnati, on June 20 on the ground that the building permit was improperly issued. At the time of the issuance of the permit a zoning law was under consideration, which after its passage prevented the construction of buildings of this type in the neighborhood of the proposed site. To obtain a permit before the zoning law went through, incomplete plans were submitted to the building department and a permit issued. Later a neighboring property owner come into court for an injunction to restrain construction of the building.

In granting this injunction the judge pointed out that the building could not be built from the plans, which contained no dimensions, gave no length for any beams or lintels, showed no elevations and no basement plan, and, declares the judge, according to the admission of the owners were not intended to be used in building the structure. "A permit to build upon the submitted plans is to do something that the building commissioner himself admits no fool would do. It is to do an impossible and an illegal act." The old building ordinance, under which the plans were submitted and the permit issued, required plans submitted in applying for a permit to be such as would suffice for the construction of the building.

Abolition of State Operation of Rys. in Sweden Recommended

A special committee appointed by the Swedish government has recommended the abolition of government operation of the railroads and the continuation of government ownership. The administration of the railroads under the new plan is to be done partly by an assembly of 29 members and partly by a board of seven directors. Nine members of the assembly will be appointed by the government, eight elected by the Riskdag, six by the employees, and six by the various outside corporations which represent public and traffic interests.

F. M. Feiker Sails to Study British Advertising

In order to enable the American producer to advertise his goods properly to the British consumer, F. M. Feiker, formerly of the McGraw-Hill Co., Inc. and now connected with the Society for Electrical Development, has been designated by the Secretary of Commerce Hoover to make an intensive study of British advertising methods. Mr. Feiker sailed from New York, July 2. He will visit the industrial centers of England to collect material which will enable the American advertiser successfully to present his wares through the printed word to the British consumer in competition with the merchants of other countries.

Work on 80,000 Hp. Hydro Plant Started by Southern Power Co.

The beginning of work on a new 80,000 hp. hydro-electric development, on the Catawba River, 12 miles from Charlotte, N. C., has been announced by the Southern Power Co. The site of the development is that of the old Catawba Power Company's plant, built about 20 years ago and forming the initial construction of what is now the Southern Power Company's system. The old plant only develops 10,000 hp. and its units will be scrapped when the new plant is completed.

The first step in the new construction is the letting of a contract to the McDowell Contracting Co., of Marion, N. C., for the construction of five miles of railway from the town of Rock Hill to the plant. The construction of the new plant will be done by the Wateree Power Co., a subsidiary of the Southern Power Co., with its own organization.

The Southern Power Company a few months ago began construction of two other power plants, one a 45,000 hp. hydro-electric plant at Rhodhiss, N. C., and the other a 40,000 hp. steam plant at Duncan, S. C.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Rochester, N. Y.; Sept. 30 to Oct. 3.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Petersburgh, Fla.; Annual Convention, Boston, Mass., Sept. 29-Oct. 3, 1924.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Fall Meeting, Detroit, Oct. 23-25, 1924.

The National Municipal League will hold its next annual meeting at Cambridge, Mass. (Harvard University), Nov. 10-12, 1924. H. W. Dodds is secretary, 261 Broadway, New York City.

Personal Notes

HERBERT GERHARDT, structural engineer, has opened an office at 628 South Myrtle Avenue, Monrovia, Calif., for consulting practice.

P. W. ETKES, assistant district engineer of the Public Works Department of Palestine, and stationed at Haifa, has arrived in this country for a month's visit. Mr. Etkes has furnished readers of *Engineering News-Record* with a number of articles on engineering development in the Holy Land.

ALBERT T. SPENCER, who has been engineer of way with the Toronto Transportation Commission since 1921, has been appointed assistant to the general manager of the commission following the promotion of D. W. Harvey to general manager. Prior to 1921 Mr. Spencer had been successively field engineer with the Dominion Coal Co., chief of a survey party for the Canadian Pacific Ry. on grade revision work in New Brunswick, Quebec and Ontario, assistant engineer of the Montreal Park and Island Electric Railway Co. and of the Montreal Street Ry. and Montreal Tramways Co., and for a time assistant engineer in the railways department of the Ontario Hydro-Electric Power Commission.

DR. CYRIL BATHO, associate professor of applied mechanics at McGill University, has been appointed professor of civil engineering at the University of Birmingham, England. Dr. Batho is a graduate of the University of Liverpool and since coming to McGill University in 1908 has done valuable research work in structural steel and bridge design.

ROBERT E. WILLEMS, for the past three years in the highway department of the city of Akron, Ohio, has been appointed county surveyor of Summit County, Ohio, succeeding in that position, Jack Weaver, recently resigned. Mr. Willems had formerly been deputy surveyor of Summit County for eight years.

JAMES STEWART, of Winnipeg, Man., has resigned from the board of directors of the Canadian National Rys., to devote more attention to his large private interests.

Obituary

GEORGE V. RECTOR, an assistant engineer in the highway department of the District of Columbia, died June 27 at his home in Washington, D. C., following a brief illness. Mr. Rector had been in the engineer department of the District of Columbia for twenty-five years; he was an engineering graduate of George Washington University.

NORMAN BOWERS, of Chambers & Bowers, contractors, Hammond, La., died recently in New Orleans, from a paralytic stroke. His firm held the contract for construction work on the Hammond City water-works and sewerage systems.

ANDREW A. CAHILL, who served as chief engineer for Patrick McGovern & Co. on construction of the 60th Street subway tunnel in New York City and in the same capacity on the Boston Army Supply Base, died July 2 at St. Vincent's Hospital, New York City, of pneumonia; he was in his 55th year. More recently, Mr. Cahill had been general manager of Abbott Merkt & Co. of New York City.

SAM SEE, superintendent of construction at Dam 38 at Rising Sun, Ind., was instantly killed June 23 when he attempted to remove a high charged wire lying across a road in the path of his motor car. Dam 38 is a construction work in the Cincinnati river district, under the U. S. Corps of Engineers. Mr. See had been in charge of the work for three years; he was 35 years old.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Construction Equipment—Past and Present

A Series of Historical Sketches of the Origin and Development of Machines for Contractors and Engineers

VI—The Road Grader

ORIGINATING about half a century ago in the form of a straight steel blade hung under the body of an ordinary four-wheel horse-drawn farm wagon, the road grader has been developed into a rugged, powerful machine, weighing 10,000 lb. or more in its larger sizes, designed for tractor haulage and equipped with control devices and special attachments which make it an economical tool of great flexibility able to cope with the varied conditions encountered in the movement of earth. In the entire category of construction equipment no other machine has played a more vital part in bringing to realization the early dreams of American highway development, railroad building, and reclamation and drainage than has the tool which came into being in 1877 when Samuel Pennock, of Ithaca, N. Y., and later of Kennett Square, Pa., secured U. S. patent No. 194,367 for "a new and improved road machine," the purpose of which was described as the "scraping and leveling of roads."

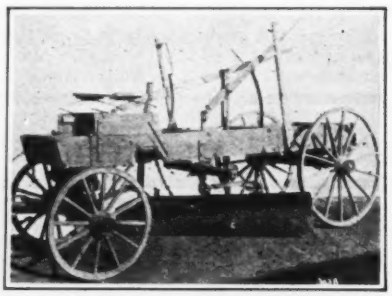
A number of years elapsed before the grader attained widespread use, but after its design had been improved and special features added, such as the introduction of a conveyor to load the excavated earth into wagons, forming the elevating grader, the machine began to receive recognition as an important aid in the development of the nation's resources, particularly in the then sparsely settled areas of the Northwest. Evidence of this appreciation of the grader is furnished by the following incident:

In the late eighties, when the grader companies were seeking to increase the distribution of their products, the Northern Pacific R.R. adopted the policy of carrying these machines into the Red River valley of Minnesota and North Dakota free of all charge on account of the great benefits they were accomplishing in land development by providing necessary drainage. This policy was continued in effect for several years.

Pennock's "New and Improved Road Machine" (1877)

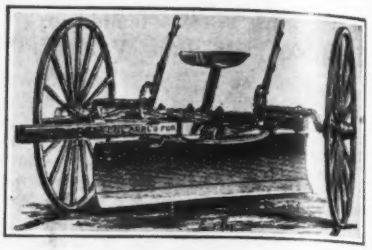
From the modern grader with its all-steel construction, its reversible and blade control features, its backsloper attachments, extensible axles, leaning wheels, offset hitches, and, in the larger sizes, 12-ft. blades, it is a long journey back to the crude lever-operated wood-frame machines of the seventies.

Pennock's Grader—Pennock's machine took definite form in 1877 and during the same year another road grader was designed and patented by H. C. Moore. The same year witnessed the development of an allied tool, the wheel scraper, by C. H. Smith & Co., railroad contractors, who were constructing an extension of the Chicago, Burlington & Quincy R.R. into Ayre, Iowa. Pennock's grader formed the foundation of the line of road-building equipment now sold by the Good Roads Machinery Co., Inc., of Kennett Square, Pa., while the Moore grader and the Smith wheel scraper were the prototypes of the modern equipment manufactured by the Western Wheeled Scraper Co., of Aurora, Ill.



Western Lever-Operated Blade on Farm Wagon

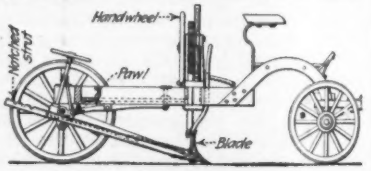
Pennock's patent of Aug. 21, 1877, covered a two-wheeled triangular framework — later equipped with four wheels — carrying a scraper blade adjustable as to height; a pair of levers allowed either end of the scraper bar to be raised or lowered. The scraper blade was fixed at an angle of about 45 deg. to the line of travel and to its front end was hinged a bar carrying a set of scarifying teeth. By means of a vertical rod this toothed bar could be raised or lowered, making it possible to operate the scraper blade either with or without the scarifying device.



Western Two-Horse Road Grader and Leveler

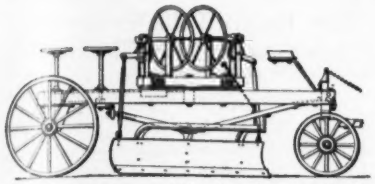
In describing the operation of the blade of his machine, Pennock said: "By operating one or the other of the levers the end of the scraper bar may be raised, so that by driving up on one side of the road and down on the other the road may be ridged or rounded, as may be desired, or by arranging the scraper bar in a horizontal position the road may be made level." The auxiliary scarifying bar could be "adjusted so that its teeth cut away the projecting and uneven portion of the surface before it is scraped." The triangular framework of this scraper was designed to be connected with the front axle of a common wagon by means of a king bolt, the machine being drawn forward by horses. The Pennock machine was of the one-way or non-reversible type and was built and sold for a number of years by the S. Pennock & Sons Co., of Kennett Square, Pa.

Reversible Principle Introduced—One of the first important steps in the improvement of the grader was made when George W. Taft, of Abington, Conn., introduced the reversible feature. He secured a patent on his device in the early eighties. The machine was known as the Lever Champion, later called the American Champion. Up to this time graders had been one-way machines with very restricted movement of the blade. The frames of these machines were of wood, the control was by a lever lift, and the blades, usually about 7 ft. long, were in one solid piece. In a patent granted to Taft Jan. 5, 1886, the drawing shows the blade hung from the middle of a four-wheeled framework. From each end of the blade a strut extends back to the rear axle. These struts are notched to engage with pawls or dogs. A chain also passes between the blade ends and around a winch-head revolved by a handwheel. With this arrangement the blade could be set at any desired angle and then locked in position by engaging the dogs in the notched struts. This grader was of the "push" type. Handwheels, instead of levers, also controlled the vertical movement of the blade.



Early Reversible Grader by Taft (1886)

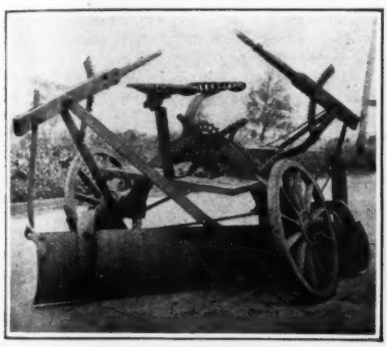
Among the pioneers in the early de-

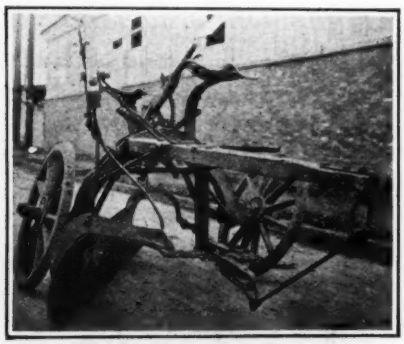


Improved Reversible Grader by Taft and Lathrop (1889)

velopment of the reversible grader, in addition to those already noted, were Marcus Cook of Wallingford, Conn., who invented the Victor reversible grader marketed for years by the Pennock Co.; the Western reversible grader was developed by the Western Wheeled Scraper Co., then located at Mount Pleasant, Ia., and the Austin was made by the F. C. Austin Manufacturing Co. The bulk of the trade in blade graders during the latter part of the eighties was divided among the Austin, the Pennock, and the Western companies. Goulds & Austin, a mill supply concern on Lake St., Chicago, and the predecessor of the present Austin Manufacturing Co., developed what is claimed to be the first all-steel reversible road machine. It was manufactured for the company during two years by the Kilbourne & Jacobs Co. of Columbus, Ohio, after which time the Austin company made the machines in its own plant in Chicago. The shift from wood to steel construction was an important step in advance, making possible larger and stronger graders, a fact of great significance in later years when tractor haulage began to replace horses.

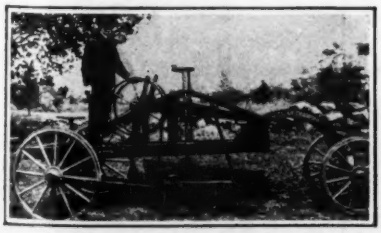
On the early machines the movement of the blade had been controlled by hand levers. In 1886 or thereabouts an innovation was made by substituting handwheels for wooden levers for raising and lowering the blades. At about this same time attention was given to better means of controlling and adjusting the position of the blades. De-





Adams Original Leaning Wheel Grader (1881)

About 1885 there was also a small two-wheeled grader called the Boss, made by a man named Pape, in Fort Wayne, Ind., and a simple, one-way iron-frame machine called the Lamborn, made in Media, Pa. Both of these machines, however, quickly passed out of existence. Taft, with E. L. Lathrop, was constructing improved wooden-frame reversible machines at Kennett Square, Pa., and these were later combined with the Victor manufactured by the American Road Machinery Co. The



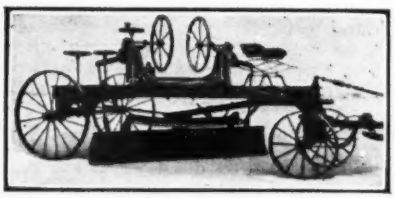
First Use of Hand-Wheel Control on American Champion Grader

Western Wheeled Scraper Co. was making a machine at Mt. Pleasant, Ia., by combining a blade attachment and necessary levers with an ordinary farm wagon. At that time the sales were few and far between and the business was struggling.

All-Steel Construction — In 1887 vices were developed for controlling its inclination and for shifting the frame of the machine on axles for bank cutting.

Adams' Leaning Wheels—Until the eighties all graders had been of the straight axle or wagon type. In 1879 a young farmer, later a road superintendent, J. D. Adams, of Marshall, Ind., sought some means of preventing the wheels of a farm wagon from binding and pinching on the axle spindles when the wagon traveled on a slope, and from skidding into the ditch when heavily loaded. In the case of the road grader he saw that the side load against the blade increased the pinch and wear on the spindles and aggravated the skidding tendency. He reasoned that on a slope the load of a grader with straight axles leaned downhill, whereas the operation of the machine would be more effective if the mass could be tilted in the reverse direction to balance the side thrust on the blade. After a period of experimenting he brought out, in 1881, his "adjustable leaning-wheel" grader,

Early Farm-Wagon Grader Showing Lever Arrangement



Improved Steel Champion, an Early Type of Reversible Grader

a small two-wheel wooden frame affair for use with horses. It had a 7-ft. blade set at a fixed cutting angle, but adjustable by wooden hand levers, as to the elevation of the ends of the blade. The essence of Adams' device, as shown in the accompanying photographs of the first machine built, was the mounting of the wheels of his machine on pivoted spindles, allowing the wheels to be inclined at any desired angle to oppose the side draft of the machine during the operation of cutting earth with a blade set obliquely to the line of travel.

Adams was a man of limited financial means and after getting the company which he represented as salesman to manufacture a few of his machines he sold them in a small way until about 1894, when he redesigned his original machine along more elaborate lines, using all-steel construction and a 7-ft. blade but retaining the two-wheel feature. This machine was widely marketed from 1894 to 1901. In 1896, however, a four-wheel framework was substituted for the two-wheel frame. In this model, however, only the rear wheels could be inclined by the driver from his platform; to shift the inclination, or "lean," of the front wheels it was necessary for the operator to get out and under the grader and turn a crank just behind the front truck of the machine. It was not until 1903 that the adjustment of all four leaning wheels was possible from the platform.

Extensible Axles—Following the introduction of Adams' leaning-wheel device, other manufacturers undertook means of preventing side slip of their grading machines. On the Western grader, for example, an extensible rear axle was introduced about 1895, allowing the frame of the machine to be shifted laterally on the rear axle. In addition, the rear axle was equipped with a pivoting device at the center to allow the wheels to be set at an angle to the line of travel. These same features were incorporated in graders of

other manufacturers, including Russell, Good Roads Machinery Co., and Galion. The sliding rear axle feature allows the rear end of the grader to be offset for purposes of keeping the machine in position on such work as ditching or cutting down a bank. With the shifting rear axle on ditch work, one rear wheel can be thrown against the bank, thus acting as a brace against side draft. The shifting of the frame on the axle is accomplished by a hand-wheel and cog bearing operated from the driving platform. The control of the pivoted rear axle is also from the operating platform by means of a hand-wheel.

Another refinement which occurred at about the time the pivotal and shifting rear axle features were introduced was a mechanism for the side shift of the grader blade by means of a hand wheel and worm gearing. This lateral shift of the blade is useful on work of widening roads and cleaning ditches, giving clearance to the front wheel.

The early road graders in most cases had the blades hung from the rear axle of the frame so that the operation of earth movement by the blade was one of pushing. In the late eighties this principle was changed over to that of a pulling action resulting from the attachment of the blade to the front axle of the machine. Later refinements included the introduction of a spring draft to reduce sudden shock in starting the machine or in encountering obstructions, and devices to vary the slope of the blade.

Major Developments—Summarizing to about 1900, these are:

(1) Reversible blades mounted on a circle instead of rigidly attached blades.

(2) Hand-wheel control instead of levers.

(3) Steel instead of wood construction for the framework.

(4) Four-wheel instead of two-wheel frame.

(5) Provision against side slip by such devices as leaning wheels, shifting frame on rear axle, and pivoted rear axle.

(6) Operation of the blade by a pulling instead of a pushing action and incorporation of spring draft device to reduce shock.

(7) Means for shifting the blade laterally and adjusting its inclination.

(More recent improvements in the grader will be described in Part II of this article, to appear in an early issue.)

Business Notes

NORTHWEST ENGINEERING CO., Chicago, announces that the George B. Curd Equipment Co., with a main office in Cincinnati and district offices in Indianapolis and Lexington, Ky., will now handle the sale of Northwest gasoline convertible cranes, draglines and shovels in that territory.

ERNEST S. PARK, vice-president of the Century Wood Preserving Co., Pittsburgh, has also been made vice-president and general manager of the New England Wood Preserving Co. with headquarters at Nashua, N. H.

EDDY VALVE & MANUFACTURING CO., East Chicago, Ind., has appointed the Dunbar Engineering Co. as its New York representative, with offices at 50 Church St.

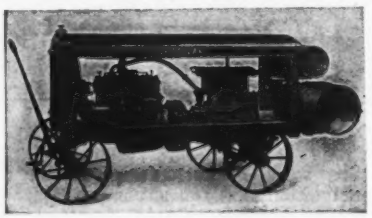
MAX RIEBENACK 3rd, of Lansdowne, Pa., is now permanently connected with the Philadelphia branch office of the Industrial Works, Bay City, Mich., as district sales engineer. Mr. Riebenack was formerly mechanical and research engineer with the National Aniline Chemical Co. and the Industrial Separators Co., Philadelphia.

FRANK C. CALDWELL, a director of the Link-Belt Co., Chicago, since the purchase of the H. W. Caldwell & Son Co., by the Link-Belt Co. in 1921, was stricken with heart failure May 15 while on his way to his bank; he died in an ambulance en route to a hospital.

Equipment and Materials

Portable Compressor for Variety of Construction Purposes

To supply compressed air for contractors' outdoor uses the Sullivan Machinery Co., Chicago, has developed a new portable 103-cu.ft. compressor.



This machine will operate a hammer drill in heavy rock excavation, one or more concrete breakers, clay spaders, riveting hammers, sand blasting or paint spraying equipment, tie tampers or pipe calking tools. It is direct-connected to a Buda four-cylinder, four-cycle gasoline engine and has a rating of 17 hp. for this duty.

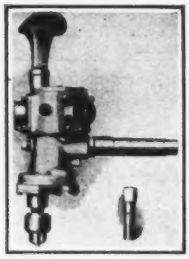
The compressor is a vertical, two-cylinder, single-acting, single-stage unit. Lubrication is automatic and cooling water for the engine and compressor is supplied by a circulating pump in the same system. The air valves are the Sullivan "wafer" type.

The compressor, engine and equipment are mounted on a one-piece steel casting. The 12-gal. gasoline tank and the 12x48-in. air receiver are carried horizontally in cradles at the rear of the truck body, and all working parts of the compressor are protected when not in use by sheet steel sides and steel canopy top.

This machine is ordinarily mounted on a steel wheel truck for highway use, weighing 3,235 lb. in this form. It may, however, be mounted on a trailer truck with rubber tires for use on city streets or on a wooden skid if maximum portability is not necessary. The machine may also be set on a Ford truck, using the No. 9 Olson extension.

New Rotary Drill Weighs 9 Lb.

A new size light-weight non-reversible pneumatic drill for drilling holes up to $\frac{5}{8}$ in. in diameter and reaming up to $\frac{7}{8}$ in. has been brought out by the Ingersoll-Rand Co., New York. It may be fitted with either breast-plate, feed screw, or grip handle for a wide variety of work. The features of this machine are: light-weight aluminum case with steel bushings cast in all the bearing holes and the throttle hole; cast-iron cylinders which are renewable and interchangeable; and special three-cylinder motor. Any cylinder after long service may easily be replaced, thus increasing the life of the motor at slight cost. The three-cylinder motor has the rotating parts all accurately balanced, eliminating vibration and reducing wear and tear on the machine. Every part is accessible for inspection.

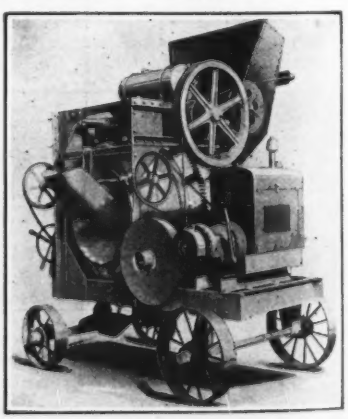


The drill operates on air at 90 lb. pressure, the speed being 700-r.p.m. Its weight is 14 lb., including breast-plate and chuck, and its length 15 in. Hose of $\frac{1}{2}$ in. diameter is recommended for use with this machine.

14-S Mixer Made More Compact

A new development of the 14-S non-tilting mixer manufactured by the T. L. Smith Co., Milwaukee, is shown in the accompanying illustration. Greater compactness of construction permits mounting on shorter trucks than formerly, thereby making the entire machine lighter, and increasing its portability. The mixer is equipped with power loader, water tank and 15-hp. four-cylinder Le Roi power unit. Strongly built gear-guards protect the workmen and at the same time prevent falling aggregate from dirtying and injuring the gears.

Designed for use on both large and small construction jobs, this mixer has



a two-bag capacity and, according to its manufacturer, gives a daily production of more than 150 cu.yd. provided the delivery of cement and aggregates is adequate to utilize the capacity of the unit.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Steel Mill Operations Down To 40 Per Cent of Capacity—Lumber Output Slower

All Building Materials Plentiful—Situation Contrasted With Year Ago When Scarcities Were Reported

Steel—Operations in the mills producing steel ingots and heavy rolled products are proceeding at about 40 per cent of capacity as against 50 per cent one month ago. Pipe mills, however, are averaging 65 per cent, while tin plates are taking only 50 per cent and steel sheets, 40 to 45 per cent of mill capacity. Demand is slow and confined mostly to small tonnage lots shipped direct from mill.

Lumber—The lumber movement for the entire country during the last week in June was one of general decline in production, orders and shipments, according to the National Lumber Manufacturers' Association. Compared with the corresponding week in 1923, however, there was a substantial increase in new business. The following figures show the lumber movement for the first twenty-six weeks of this year as compared with the same period in 1923:

	Production Ft. b.m.	Shipments Ft. b.m.	Orders Ft. b.m.
1924....	6,112,779,250	5,998,951,459	5,626,172,360
1923....	6,079,922,795	6,447,656,782	6,041,402,168
1924 (Increase	32,856,455	.....	.....
1924 (Decrease).....		448,705,323	415,229,808

A weekly comparison of lumber movements follows:

	Week Ended June 28 Ft. b.m.	Corresponding Week in 1923 Ft. b.m.	Preceding Week in 1924 Ft. b.m.
Mills	359	380	371
Production	217,512,993	259,366,887	220,475,539
Shipments	201,538,954	238,249,310	208,462,046
Orders	196,764,147	179,191,469	210,080,528

Cement—The output for the entire country during the first five months of the current year was 53,249,000 bbl., according to the Geological Survey. This represented a gain of over 5 per cent compared with the corresponding period in 1923. Shipments from mills, however, were 47,460,000 bbl., a decrease of 3 per cent from the first five months of last year. With this increase in output and decline in shipments, a heavier reserve supply at the mills was made possible. If the 1923 production trend is followed this year, a drop of about 500,000 bbl. may be expected in the June reports. June 1922, however, showed a gain of 250,000 bbl. over the month preceding.

Brick—Reports from the Common Brick Manufacturers Association of America, as of June 1, state that unfilled orders increased 13 per cent; shipments from yards, 6 per cent; finished brick on hand, 3 per cent and unburned brick, 24 per cent during the preceding month. There were also fewer plants closed down. The current situation compared with a month ago and one year ago, is shown in the following tabulation:

	Burned Brick on Hand M	Unburned Brick on Hand M	Brick Moved from Yards During Month M	Orders on Books M
1923 June 1.....	137,520	33,669	.....	403,691
1924 Jan. 1.....	313,696	55,646	66,199	266,914
Feb. 1	306,503	38,349	45,762	272,403
Mar. 1.....	282,813	39,695	104,663	263,219
Apr. 1	250,118	46,226	142,197	335,926
May 1	238,703	58,972	169,855	382,778
June 1	223,458	70,802	163,298	394,156

With steel mill operations down to 40 per cent of capacity, a decrease reported in the national lumber output and general curtailment of production evident in most of the basic industries, reports are now coming in from dealers' warehouses throughout the country to the effect that reserve stocks are ample for all present demands. This situation is contrasted with that of a year ago when brick and cement scarcities were reported. During July, 1923, however, there was a seasonal slowing down in the steel and lumber output.

Large Contracts Let During Week

Among the week's announcements of contracts awarded in Construction News, pp. 13 to 25, are the following:

Repair shops, Hayne, S. C., Southern Railway System to D. P. Robinson, New York City, $3,000,000.

Bridge, Jersey City, N. J., Bd. Freeholders Hudson Co. to Stillman, Delehanty & Ferris Co., $1,342,783.

Factory, Hull, Que., E. B. Eddy Co., Ltd. to Anglin Norcross, Ltd., Montreal, $1,000,000.

CONDITIONS OF MATERIALS STOCKS IN IMPORTANT CENTERS

Stocks on hand in approximate figures, example: (Lumber, Denver, 40,000,000 ft.); time required for delivery of carload lots to city job, example: (Hollow tile, Atlanta, deliveries take 4 to 5 days); and stocks on hand in general terms, example: (Sewer pipe, Cincinnati, plenty, all sizes).

	San Francisco	Denver	Minneapolis	Detroit	Cincinnati	New Orleans	Atlanta	Philadelphia	New York
Sewer pipe.....	Stocks large	Just about even with demand	Stocks ample in city; mill del. prompt	Moderate supply in local yards	Plenty; all sizes	Plentiful; demand normal	Del. take four to five days	Stocks maintained above 100 cars	Dealers' stocks usually small; mill del. prompt
Cement.....	Dealers stocks in good shape	Stocks in good shape	Large quantities available; mill del. prompt	Abundant supply at local mills	Readily obtainable	Abundant; fair demand	About 70 to 80 cars on sidings	Between 75 and 100 carloads	More on hand than year ago
Lime.....	Fairly well supplied	Sufficient	Quick del. from source	Prompt del. from Ohio and Mich. kilns	Adequate supplies	Sufficient	About 75 to 100 cars at hand	Stocks ample for current demands	Dealers' stocks usually small; mill del. prompt
Common brick....	Large reserves	Small quantity at hand	Yards heavily stocked; many closed down	Ample supply in local yards	Plentiful	Adequate; normal demand	Plenty	Yard stocks ample	Ample for the season's demand
Hollow tile.....	Enough	Just about even with demand	Yards heavily stocked; some closing down	Moderate stocks on hand	Ample	Normal; demand fair	Del. take four to five days	Limited quantity kept in city	Dealers' stocks usually small; prompt del. by rail and water
Lumber.....	Very large yard stocks	40,000,000 ft.	100,000,000 ft.; normal for season	Good supply in local yards	Adequate stocks in dealers' yards	Mills closing down	Plenty	Yards carrying heavy reserves	Stocks heavier than year ago
Asphalt.....	Native reserves	Limited quantity on sidings	Quickly obtainable from source	.....	Plenty	200 tons; 2,000 needed	About 75 to 80 cars	Enough for requirements only	Heavy reserves near city
Structural steel...	Heavy warehouse stocks of steel bars	Warehouses well stocked	Large quantities available; demand slow	Normal stocks in fabricating shops	Warehouse demand in small tonnage lots	Ample supplies in warehouses	About 4 to 5 cars	Warehouse stocks small; prompt mill del. on all important contracts	Small lot purchasing from warehouse stocks

New York City Contracts Only 7 Per Cent of Total

It has often been said this year that New York City work is the chief element in the high volume of contracts being awarded. It has been intimated that elsewhere in the country the construction industry is not doing so well.

Engineering News-Record statistics show that the influence of New York City Construction is actually smaller this year than last. The following are the values of New York contracts in May and June of 1923 and 1924 and their percentages of the totals for the Middle Atlantic States and for the United States.

	Value	Per Cent of Mid. Atlantic	Per Cent of United States
May, 1924	$16,205,000	24	6½
May, 1923	12,384,000	24	6½
June, 1924	12,604,000	28	8½
June, 1923	31,698,000	73	18

The figures for May are practically identical for both years. The June percentages are reasonably comparable with those of May 1923 and 1924. The reason for the departure in June, 1923, is the inclusion of three contracts totaling $22,226,000.

Contract-letting, though slower, is still active throughout the entire country. New York City is doing its share, but the rest of the land is keeping abreast.

Bids Wanted on Big Jobs

Among the projects on which bids are either asked or will soon be called for in Construction News, pp. 13 to 25, are the following:

Sewers, Richmond, Va., Dir. Pub. Wks., $1,650,000.

Viaduct, Philadelphia, Pa., Pennsylvania R.R., $1,250,000.

High School, Denver, Colo., Bd. of Educ., $1,000,000.

Drainage canals, Shrewsbury, La., Bd. Comrs., $1,250,000.

Dam, Dallas, Tex., Mayor and City Comrs., $5,000,000.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of July 3, the next, on August 7.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$3.44	$3.80	$4.20	$3.30	$3.45	$4.10	$3.60	$3.60	$4.20
Structural rivets, 100 lb.	4.00	4.35	4.90	—3.65	3.90	5.15	5.00	4.25	5.00
Reinforcing bars, ¾ in. up, 100 lb.	3.34	3.30	3.38	—3.10	3.35	+3.87½	3.65	3.50	2.70
Steel pipe, black, 2½ to 6 in. lap, discount	44%	55%	43%	47%	55.05%	36%	36.80@49.10%	45%	47.43
Cast-iron pipe, 6 in. and over, ton	60.60@61.60	45.50	59.00	57.20@60.20	58.50	68.00	59.00	65.00	60.00
Concreting Material:									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.20	2.42	2.84	2.61	2.90	1.90
Gravel, ¾ in., cu.yd.	1.75	2.00	2.38	2.00	1.85	1.90	2.15	1.50	1.25
Sand, cu.yd.	1.00	1.40	2.00	2.00	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.00	2.83	2.00	1.75	3.50	2.15	3.00	2.25
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	—54.00	—36.00	57.20	51.50	38.75	+36.75	36.00	23.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	—18.00	25.50	24.00	22.60	24.00	21.00
Lime common, lump, per bbl.	3.00@3.25	1.65	1.85	1.50	1.40	2.70	+2.15	2.80	10.50
Common brick, delivered, 1,000	23.65	—11.00	14.11	11.00	13.00	12.00	15.50	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.091	.11	—.062	.08	.075	.....	.11	.12
Hollow partition tile 4x12x12, per block	.1162	.091	.11	.....	.....	.075	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	+1.00	—1.01	1.14	.94	1.08	1.18	1.05	1.13	1.01
Common Labor:									
Common labor, union, hour	.75	.30	.....	.....	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	....	.25	.30@.50	+.87½	.50@.55	.35@.50	.50	.62½	.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Labor—Concrete laborers' rate, 93¾c.; building laborers (pick and shovel men) 75c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; lump finishing lime p r 200-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.80 for Kelly Island and $1.70 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand stone, gravel and lump lime per ton. Stone, lime and tile are delivered; sand, gravel and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.25). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3-in., $47.43; 6-in. $119.

Conditions Affecting the Market

Price declines continue to predominate in the building materials market. During the past two weeks there have been recessions in reinforcing bars, pine lumber, lime and clay products in various parts of the country. Advances, however, occurred in fir timbers and linseed oil.

The gradual downward trend of construction cost, since the first of May, is shown by the chart on the opposite page. It is to be noted that the descent has not been abrupt despite the sharp curtailment in production evident during the past three months.

A drop in demand for building materials is shown by the falling off in volume and value of contracts awarded during the past two months.

When demand is slow or prices drop to levels too near the cost of production to suit the manufacturers, curtailment of output becomes the rule rather than further reduction of price schedules.

Reports received by *Engineering News-Record* from various parts of the country indicate that both mill and dealers' warehouse stocks are sufficient to meet this season's requirements. Production will, therefore, remain at low ebb until sufficient demand arises to consume existing stocks of materials.

With these reserve stocks absorbed and the building "boom" still showing signs of activity, price advances rather than recessions are to be expected.

e Revis
st of Pi